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An autosegmental theory of stress

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AN AUTOSEGMENTAL THEORY OF STRESS

by

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As members of the Final Examination Committee, we certify that we have read the dissertation prepared by Lawrence Raymond Hagberg

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ABSTRACT

This study proposes that metrical constituents are inherently headless and stress is autosegmental. Chapter 2 argues that, since stress is the only diagnostic for the presence of a metrical head, the latter is redundant and must be eliminated from phonological theory. Further arguments for the inherent headlessness of feet are cited from the theory of prosodic morphology (McCarthy and Prince 1990, Crowhurst 1991b) and from the facts of Yidin^y stress (Dixon 1977, Crowhurst 1991a, Crowhurst and Hewitt, to appear). Next, stress is shown to exhibit the following autosegmental properties: stability (Bedouin Hijazi Arabic), morphemic stress (Spanish, Turkish, Tagalog) and the ability to float (Mayo, Tagalog). After comparing the properties of stress with those of autosegments, it is concluded that stress is an autosegment.

Assuming that feet can be either disyllabic, bimoraic or iambic (Hayes 1991), the above conclusion predicts the existence of five types of binary stressed feet. These are the left- and right-stressed syllabic foot, instantiated by Warao and Mayo, respectively, the left- and right-stressed moraic foot, instantiated by Cairene Arabic and Turkish, respectively, and the iambic foot, instantiated by Hixkaryana. The asymmetric nature of the iamb is attributed to the Weight-to-Stress Principle (Prince 1990), which allows stress to be assigned directly to heavy syllables. Furthermore, this principle predicts all and only the attested types of unbounded stress systems. Chapter 5 argues that stressless feet and unfooted stresses are instantiated in Mayo, and the theories of Halle and Vergnaud 1987a, b and Hayes 1987, 1991 are shown to be incapable of accounting for these facts.

The autosegmental theory of stress advances phonological theory in three ways. First, it eliminates most of the principles and devices which up to now have been used only to describe stress, leaving only the abstract stress autosegment which is itself subject to the principles of autosegmental theory. Second, this approach attributes many of the apparent differences between stress and tone to differences in their respective domains rather than differences in their formal properties. Third, the autosegmental theory of stress facilitates the formalization of a number of stress systems with heretofore complex analyses, including Yidin^{y}, Mayo, Cairene Arabic, Turkish, Khalkha Mongolian and Tagalog.

CHAPTER 1

INTRODUCTION

1.1. Overview: The Need for a New Theory of Stress.

A basic premise of generative grammar is that each natural language consists of a very small number of semi-autonomous abstract systems, each one comprised of a finite inventory of universal, binary-valued variables and constrained by a set of universal principles.[1] Language-particular differences in the setting of these variables, commonly called *parameters*, are assumed to account for all the ways in which grammars vary from one language to another. In other words, the generative approach assumes that every language has a grammar that adheres rigorously to some set of universal laws and which differs from the grammars of other languages in only a few very simple ways. In this view, the seemingly chaotic surface alternations of any language may be accounted for by correctly selecting one of two possible values for each of a handful of universal linguistic parameters.

This study focuses on the difference between two abstract linguistic systems: metrical phonology and autosegmental phonology. Metrical theory was originally developed in order to account for a large body of prosodic phenomena known as *stress*. Autosegmental theory, on the other hand, was first developed in order to account for certain cross-linguistic regularities in the distribution and function of *tone*. Since its introduction, the application of autosegmental theory has been extended

[1]Some parameters have more than two possible values, but even for these parameters the number of possible values is still small.

in order to account for a number of other features besides tone, including [NASAL], [ADVANCED TONGUE ROOT] ([ATR]), [ROUND] and [BACK]. For the most part, however, the body of phenomena collectively known as *stress* has been considered to lie outside the realm of autosegmental theory. Although stress is realized phonetically as tone in a number of languages, its phonological behavior has been considered to be distinct enough from that of tone to warrant the claim that stress and tone are independent phenomena, at least at some abstract level. The present study is concerned with the following question: What is it that formally distinguishes these two sets of phenomena from one another?

Accordingly, this study is centered around two major claims. The first of these is that stress is formally autosegmental. This means that all apparent phonological differences between stress and tone (or any other autosegment) are due to their different domains rather than to any difference in the principles under which they operate.

This is not intended to imply that tone is the only phonetic manifestation of stress. Rather, the claim is that stress, like tone, is capable of functioning as an autosegment, and that all stress-related rules should be expressed using the same formalism that is used for other phonological processes. A full discussion of the phonetic features of stress is beyond the scope of this thesis.

This study's second major claim, which is closely related to the first, is that all feet are inherently headless. As such, they are available as domains for any kind of operation, including the insertion

of an autosegmental feature of prominence. When the latter occurs, we have what is typically known as stress.

Thus, this study is a proposal about metrical theory and the manner in which it differs from or is similar to autosegmental theory. Specifically, it is argued that (i) all feet are inherently headless and (ii) whenever stress is assigned to a foot or any other domain, it is assigned via the principles of autosegmental theory.

A clarification of terms is in order at this point. In generative grammar, the term *head* is normally used to define a formal relationship between two or more elements, whereas *stress* refers to the presence of phonetic features which in many cases have been used as a diagnostic to determine grouping known as *metrical structure*. It has been assumed by many researchers (e.g., Halle and Vergnaud 1987a, b, Hayes 1987, 1991 and Crowhurst 1991b) that a stressed element is necessarily the head of some metrical structure. However, given my claim that stress functions as an autosegment (i.e., an autonomous feature), there is no way for a grammar to ensure that stress will always mark headship. Furthermore, since this proposal views feet as inherently headless, it would be inconsistent to view a stressed element as the head of some metrical structure. Throughout this study, therefore, whenever a stress autosegment has been assigned to a foot, I refer to that foot as a *stressed foot* rather than a *headed foot*. Thus, by avoiding the term *head* (except in chapter 2's formal arguments for the inherent headlessness of feet), it is possible to distinguish between stressed feet and stressless feet by the presence or absence of a stress autosegment, respectively.

The remainder of this chapter overviews four theories which are assumed (in part) for many of the arguments in this thesis, and then an outline of the remaining chapters is presented.

1.2. Background.

This section briefly reviews four theories which play important roles in the central proposal of this thesis. The first of these is *moraic theory* (Hyman 1985, Hayes 1989), which is foundational not only to my proposal but also to the approaches to metrical theory that I argue against. The second theory to be reviewed is that of Hayes 1987, 1991, which proposes a universal inventory of three primitive metrical feet. Hayes' theory is important to this study because chapters 2 and 3 argue for a modified version of Hayes' inventory of feet in which all feet are inherently headless. The third theory, which is generally known as *lexical phonology* (Kiparsky 1979, 1982, 1985, Mohanan 1982, 1986, Halle and Vergnaud 1987a and b), concerns the manner in which morphology interacts with phonology. The fourth theory is concerned with the formalization of the *Obligatory Contour Principle* (Leben 1973, Archangeli 1985, McCarthy 1986, Myers 1987, Odden 1988, Yip 1988a), which prohibits the occurrence of adjacent identical features in a phonological representation. I discuss each of these in turn below.

1.2.1. Moraic Theory.

The fundamental claim of moraic theory is that the only element intervening between the syllable node and the segmental root node is the

mora. The moraic model of the syllable was first formalized in Hyman 1985 and further developed in Hayes 1989. Under this approach, the syllable contains neither an onset nor a rhyme.[2] Instead, every syllable contains one or more *moras* (μ), as shown in (1). Each *X* represents a segment; parentheses indicate optionality.

(1) Hayes 1989:

```
     (a) Light Syllable:                (b) Heavy Syllables:

            σ                                  σ               σ
           /|                                 /|\             /|\
          | μ                                | μ μ           | μ μ
          |  |\                              | | |           | |/|
         (X)X(X)                            (X)X X          (X)X(X)

         ta, tat                              tat           taa, taat
```

Notice that the distinction between a heavy syllable and a light syllable is expressed entirely by the number of moras in the syllable; the segment count is irrelevant. Thus, the representation in (1a) has exactly one mora; this is what distinguishes it as light. If it has an onset and/or coda, the former is adjoined directly to the syllable node without any intervening structural node and the latter is adjoined to the mora.[3,4] In contrast, each of the representations in (1b) has two moras; this is what distinguishes each syllable as heavy. Again, if

[2]See Halle and Vergnaud 1980 and Harris 1983 for discussion of the onset-rhyme model of syllable structure.

[3]Katada 1990 and Ishihara 1991 argue that Japanese onsets are in fact adjoined to the mora, as in Hyman's 1985 model, rather than to the syllable. Peng 1992 argues that this is true of other languages as well. This issue has no direct bearing on a theory of stress because the number of moras per syllable is the same under both models.

[4]The term *coda* is used in a purely descriptive sense to refer to any consonant that is in the same syllable with a preceding vowel. Likewise, the term *onset* refers to any syllabified consonant that is not a coda.

there is an onset, it is adjoined directly to the syllable node. However, the status of the coda, if there is one, may vary in heavy syllables: If the preceding material is bimoraic, then the coda is adjoined to the second mora; it does not project a third mora.[5] If, on the other hand, the preceding vowel is monomoraic, then the coda must project a second mora (i.e., it is *moraic)* in order for the syllable to be considered heavy.

The basic argument for the existence of the mora stems from the observation that syllables in many languages exhibit a *weight* distinction, i.e., certain phonological rules (including, but not limited to, rules of stress assignment) distinguish syllables that contain two moras from those that have only one. Since this weight distinction generally ignores onsets, it cannot be expressed in terms of the number of segments in a syllable. Therefore, Hyman 1985 explicitly argues for the existence of the mora (which he refers to as a *weight unit)* as a fundamental prosodic unit.[6]

In summary, moraic theory attempts to account for phonological processes which refer to constituents that are intermediate between segments and syllables. The motivation for moraic theory comes from the observation that, although no linguistic process has ever been found in which the total number of segments within a syllable is counted, never-

[5]Although Hayes 1989 assumes this in most of his discussion, he also points out that there is evidence for trimoraic syllables in Proto-Germanic, Hindi, Dutch, Danish, Persian and Estonian. I assume that the theory of stress proposed in this thesis is able to account for these languages, since my theory makes no assumptions about how many moras may occur in a syllable.

[6]See Trubetzkoy 1969 for an early discussion of such weight distinctions.

theless many languages exhibit counting of a subset of the segments of each syllable: the moras.

Having laid the foundation of moraic theory, I next review Hayes' 1987, 1991 proposed inventory of primitive metrical feet. A modified version of Hayes' inventory, in which all feet are inherently headless, is proposed and argued for in chapter 2.

1.2.2. The Metrical Theory of Hayes.

Hayes 1987, 1991 argues for the inventory of primitive foot types that is shown in (2).[7,8] The * in each case represents prominence, i.e., the head of the foot; a period (.) represents non-prominence.[9] In the representations of the moraic trochee and the iamb, the *or* construction means that the leftmost structure is built wherever possible; otherwise, the rightmost structure is built. In the case of the iamb,

[7]Hayes 1981 uses a different system to categorize stress. Under this account, a language has quantity sensitive (QS) stress if the non-heads of feet are restricted to light syllables, and a language has Obligatory Branching (OB) stress if the non-heads of feet are restricted to light syllables and the heads of feet are restricted to heavy syllables. Except where otherwise noted, all discussions of Hayes' theory refer only to Hayes 1987, 1991, and not to Hayes 1981. Also, Hayes 1987 allows degenerate feet in some instances where Hayes 1991 does not allow them. The question of degenerate feet is discussed in chapter 2.

[8]In addition to the primitive metrical feet proposed in Hayes 1987, 1991, Dresher and Lahiri 1991 argue for the existence of an uneven trochee ($\mu\mu$ σ) in Old English. Ishihara 1990 cites evidence for a heavy morphological foot ($\mu\mu$ $\mu\mu$) in Okinawan Japanese, and Hammond 1990b argues for the use of this foot in the stress system of Lenakel; Crowhurst 1991b also discusses the latter two languages. The question of whether or not such feet exist is not relevant here, since their existence may be straightforwardly accomodated by the theory that I propose.

[9]Hayes uses x instead of * to represent metrical heads. Throughout this study, I follow Halle and Vergnaud 1987a and b in utilizing * to represent not only metrical heads but also (on a lower line) all potential stress-bearing units. The use of * to identify potential stress-bearing units is discussed in section 2.1.1.

there is a three-way hierarchy of preferences; Hayes refers to the left-most representation as the preferred or *canonical* iambic foot.

(2) Hayes' 1987, 1991 Foot Inventory:

KEY: σ_{μ} = light syllable; $\sigma_{\mu\mu}$ = heavy syllable; σ = any syllable

Syllabic Trochee:	(* .) $\sigma\ \sigma$			
Moraic Trochee:	(* .) $\sigma_{\mu}\sigma_{\mu}$ or	(*) $\sigma_{\mu\mu}$		
Iamb:	Preferred:		Else:	
	(. *) $\sigma_{\mu}\sigma_{\mu\mu}$		(. *) $\sigma_{\mu}\sigma$ or	(*) $\sigma_{\mu\mu}$

Hayes' theory assumes that the above three foot types are always constructed with inherent heads and that no other kinds of stress feet are possible. I return to this point in chapter 2, where it is argued that stress and foot structure must be formally separate. As a consequence of this conclusion, chapter 3 argues that right-stressed syllabic feet and right-stressed moraic feet are attested in Mayo (a Uto-Aztecan language) and Turkish, respectively, contrary to Hayes' claim that such feet do not exist.[10]

Before going on, however, each of Hayes' primitive foot types -- the syllabic trochee, the moraic trochee and the iamb -- is illustrated below using data from Warao, Cairene Arabic and Hixkaryana, respectively.

---

[10]I use the term *right-stressed* in place of Hayes' term *right-headed* in order to be consistent with my central claim that stress and foot structure are logically separate. However, when citing analyses from other works (such as Hayes 1991, discussed below) which assume that feet have inherent heads, I will use the terms *right-* and *left-headed*.

The stress system of Warao, a language of Venezuela, provides a simple example of the syllabic trochee. According to Osborn 1966, primary stress in Warao falls on the penultimate syllable in most words, as illustrated in (3). Secondary stresses occur on every other syllable preceding primary stress. Primary and secondary stresses are indicated by acute and grave accents, respectively.

(3) Warao (Osborn 1966):

tíra	*woman*
apáu	*well placed*
koránu	*drink it!*
rùhunáe	*he sat down*
yiwàranáe	*he finished it*
nàhoròahàkutái	*the one who ate*
yàpurùkitànehás e	*verily to climb*

Osborn reports a few instances of primary stress occurring on the final syllable or on the antepenultimate syllable, but the alternating secondary stresses are always determined by the placement of primary stress. Hayes does not comment on these exceptional forms, but I assume he would use lexical accent and/or extrametricality to account for them. Hayes 1991 accounts for the basic pattern in (3) with the following rule:

(4) Stress Assignment in Warao (Hayes 1991):

Form syllabic trochees from right to left.

Applying this rule, words containing an even number of syllables will be exhaustively footed, as illustrated in (5).

```
(5)  Input:              Build 1st Foot:     Build 2nd Foot:

                                     *         *         *
      σ    σ    σ σ       σ    σ   (σ σ)      (σ    σ) (σ σ)
     /|   /|   /| |      /|   /|   /| |       /|   /|  /| |
     r u h u n a e       r u h u n a e        r u h u n a e
```

In order to derive the difference between primary and secondary stress, Hayes applies the *End Rule* (6) to the output of (4). The End Rule, which was first proposed in Prince 1983, has the effect of promoting a single stress, either the leftmost or the rightmost, so as to make it more prominent than all the other stresses in the word.[11]

(6) End Rule right.

Languages vary as to which stress gets promoted, but Hayes 1991 follows Prince 1983 in assuming that the End Rule can apply only to a peripheral stress, i.e., either the leftmost or the rightmost.

The application of End Rule right is illustrated below. Notice that Hayes formalizes this rule by grouping all of the previously-derived stresses into a single constituent, which Hayes refers to as a *word tree*, and then inserting another stress mark above the rightmost member of this constituent.[12]

---

[11]The End Rule is only one of many devices which have been proposed in order to derive contrastive degrees of stress. Since this study is concerned only with the basic contrast between stressed and stressless elements, I generally avoid discussing the relative merits of the End Rule as opposed to other devices. However, section 3.2 suggests that the End Rule may be redundant given the theory proposed here. Also, section 6.1 proposes an autosegmental version of the End Rule.

[12]Liberman 1975 was the first to represent hierarchical stress using columns of identical elements.

(7) <u>Output of (5)</u>: <u>End Rule Right</u>: <u>Final Output</u>:

```
                              *
 *       *           (*       *)
(σ   σ) (σ σ)        (σ   σ) (σ σ)
/|  /|  /| |         /|  /|  /| |
r u h u n a e        r u h u n a e        rùhunáe
```

As was demonstrated in (5), words containing an even number of syllables are exhaustively footed. However, since degenerate feet are forbidden under Hayes' theory, any word that has an odd number of syllables will correctly end up with an unfooted (hence, unstressed) initial syllable, as in (8).

(8) <u>Input</u>: <u>Build 1st Foot</u>: <u>Build 2nd Foot</u>: <u>Output</u>:

```
                            *
 σ   σ   σ           σ  (σ   σ)
/|  /|  /|          /|  /|  /|         Blocked:  No
k o r a n u         k o r a n u        degenerate feet     koránu
```

Thus, Warao is an example of a language in which syllabic trochees are built iteratively from right to left.

Next, I review Hayes' 1991 analysis of the stress pattern of Cairene Arabic as an example of moraic trochees. The data are from Langendoen 1968 and are also found in McCarthy 1979 and Halle and Vergnaud 1987b. The facts of Cairene Arabic stress may be summarized as follows:

(9) <u>Stress in Cairene Arabic</u>:

(a) Stress is on the last syllable, if it is superheavy.
(b) Otherwise, stress is on the penult, if it is heavy.
(c) Otherwise, stress is on the antepenult or penult, whichever is separated by an even number of syllables from the immediately preceding heavy syllable, if there is one, or from the beginning of the word if there is none, where zero is counted as even.

The term *superheavy* means that a syllable has three segments which would normally be counted as moraic. However, superheavy syllables occur only in word-final position, so their prosodic status is open to debate.[13] Each of the three cases described in (9) is illustrated in (10): The final syllable is superheavy in (a) but not in (b) or (c), which correspond to (9)(b) and (c), respectively.

(10)	(a)	katábt	*I wrote*	sakakíin	*knives*
	(b)	qamálti	*you (f.sg.) did*	hadáani	*these (f.du.)*
	(c)	martába	*mattress*	búxala	*misers*
		katabítu	*they wrote*	kátaba	*he wrote*
		shajarátun	*tree*	shajarátuhu	*his tree*
		'adwiyatúhu	*his drugs*	'adwiyatúhumaa	*their drugs*

Hayes 1991 derives the above stress patterns as follows:

(11) <u>Stress Assignment in Cairene Arabic</u>:[14]

a. Mark a final mora extrametrical except when it is the only mora in the syllable.

b. Parse the word from left to right into moraic trochees.

c. End Rule right.

---

[13]McCarthy and Prince 1990 claim that trimoraic syllables do not exist in Arabic. Specifically, they claim that the third 'mora' of a superheavy syllable is extrasyllabic. The facts of stress do not seem capable of resolving this issue for the following reason. Since a final heavy syllable has no effect on the stress pattern, it is necessary to postulate a rule which renders either the final mora or the final segment extrametrical, as discussed below. Either way, it is not possible to determine, on the basis of stress, whether the final segment of a superheavy syllable is non-moraic or whether it is actually moraic but invisible as a result of the extrametricality rule.

[14]Step (a) actually consists of two different extrametricality rules in Hayes 1991. Since all the correct forms appear to be derivable from a single rule, I have modified Hayes' analysis accordingly.

The application of the above rules is illustrated in (12), where *EM* refers to the extrametricality rule (11a):

```
(12) Input:        EM:        Build Feet:       End Rule:         Output:

                                                    *
                               *    *          (*       *)
     μ μ μ μ                  (μ μ) (μ μ)      (μ μ) (μ μ)
     | | | |                   | |   | |        | |   | |
     katabitu      N/A         kata bitu        kata bitu         kàtabítu
```

Notice that the predicted output is *kàtabítu*, with secondary stress on the first syllable. Although there is some disagreement over the question of whether or not Cairene Arabic exhibits secondary stress, Hayes 1991 claims that secondary stress is attested in the predicted places by the fact that a vowel bearing secondary stress fails to undergo a phrasal syncope rule (Kenstowicz 1980) which applies to stressless vowels.[15]

Now consider what happens when a word contains three short syllables, as in (13). Since foot-building occurs from left to right, the first two moras are incorporated into a foot, but the third mora remains unfooted because of the ban on degenerate feet.

```
(13) Input:        EM:        Build Feet:       End Rule:         Output:

                                                 *
                               *                (*)
     μ μ μ                    (μ μ)  μ         (μ μ)  μ
     | | |                     | |   |          | |   |
     buxala        N/A         buxa la          buxa la           búxala
```

---

[15] In fact, Hayes 1991 uses this to argue against one aspect of the theory proposed in Halle and Vergnaud 1987a and b. See footnote 6 in section 2.1.1 for a discussion of the relevance of this matter to my proposal.

Thus, when all of the syllables in a word are light, the stress pattern is determined by whether the overall syllable count is odd or even. However, this method will not account for the stress pattern of words such as *qamálti*. In order to account for this stress pattern, it is necessary to appeal to the principle of *Syllable Integrity*, which was first proposed in Prince 1975:

(14) <u>Syllable Integrity</u>: Every foot boundary must coincide with a syllable boundary.

This principle simply means that no foot boundary may occur in between two tautosyllabic moras.[16]

The impact of Syllable Integrity on Cairene Arabic stress is that a monomoraic syllable in between two bimoraic syllables (or between the edge of the word and a bimoraic syllable) will never be incorporated into a foot. To do so would violate either the ban on degenerate feet, by making that mora into a monomoraic foot, or the Syllable Integrity Principle, by building a foot from the lone mora plus a single mora from the bimoraic syllable.[17] The violations are illustrated in (15).

(15) <u>Illicit Degenerate Foot</u>: <u>Violation of Syllable Integrity</u>:

```
      σ     σ     σ                σ     σ     σ
     / \    |    / \              / \    |    / \
  * (μ   μ) (μ) (μ   μ)        * (μ   μ) (μ   μ)  μ
```

---

[16]See Rice 1990 for the use of Syllable Integrity in deriving Pacific Yup'ik stress.

[17]A third logical possibility would be to incorporate the lone mora into a foot with the two moras of an adjacent syllable. Hayes allows this for iambs, as discussed below, but not for trochees.

The effect of Syllable Integrity upon the output of foot-building in *qamálti* is illustrated in (16). Notice that the first mora cannot be incorporated into a foot with the following mora in this case, because to do so would create a syllable-internal foot boundary. Consequently, the first mora remains unfooted and stress ends up on the heavy syllable.

(16)

<u>Input</u>:	<u>EM</u>:	<u>Build Feet</u>:	<u>End Rule</u>:	<u>Output</u>:
			*	
		*	(*)	
μ μμ μ		μ (μμ) μ	μ (μμ) μ	
qamalti	N/A	qa mal ti	qa mal ti	*qamálti*

As evidence for the claim that the initial vowel in such words is unfooted, Hayes points out that the aforementioned phrasal syncope rule applies to the initial vowel in forms such as *qamálti* but not to the initial vowel in forms such as *kàtabítu*, for which there is independent evidence that the first vowel belongs to a binary foot.

Hayes' rule of final mora extrametricality is motivated by forms which end in a heavy syllable, such as *shajarátun*. Without the extrametricality rule, the two moras of a final heavy syllable would be incorporated into a foot, as demonstrated in (17).

(17)

<u>Input</u>:	<u>EM</u>:	<u>Build Feet</u>:	<u>End Rule</u>:	<u>Output</u>:
			*	
		* *	(* *)	
μ μ μ μμ		(μ μ) μ (μμ)	(μ μ) μ (μμ)	
shajaratun	N/A	shaja ra tun	shaja ra tun	**shàjaratún*

In fact, stress never occurs on a final heavy syllable. The only way to derive this fact is to somehow ensure that final heavy syllables are treated as light syllables. As stated in (11a), Hayes achieves this via the rule of final mora extrametricality. Accordingly, the derivation of *shajarátun* proceeds as in (18), where the final syllable is treated as light.

(18) <u>Input</u>: <u>EM</u>: <u>Build Feet</u>: <u>End Rule</u>:

```
                                                                *
                                       *     *              (*      *)
   μ μ μ μμ          μ μ μ μ<μ>      (μ  μ) (μ  μ) <μ>      (μ  μ) (μ  μ) <μ>
   | | | ||          | | | | |        |  |   |  |   |        |  |   |  |   |
  shajaratun        shajaratu n      shaja ratu    n        shaja ratu    n
```

<u>Output</u>:

shàjarátun

Likewise, the stress pattern of *'adwiyatúhumaa* is correctly derived by invoking final extrametricality:

(19) <u>Input</u>: <u>EM</u>: <u>Build Feet</u>:

```
                                                          *     *     *
  μμ μ μ μ μ μ μ        μμ μ μ μ μ μ<μ>           (μμ) (μ  μ) (μ  μ)  μ<μ>
  || | | | | | |/       || | | | | |/              ||   |  |   |  |   |/
  'adwiyatuhuma         'adwiyatuhuma              'ad  wiya   tuhu   ma
```

<u>End Rule</u>: <u>Output</u>:

```
               *
  *    *       *
 (μμ) (μ  μ) (μ  μ)  μ<μ>
  ||   |  |   |  |   |/
 'ad  wiya   tuhu   ma            'àdwiyatúhumaa
```

Although extrametricality prevents stress from occurring on a final heavy syllable, it cannot prevent foot-building from occurring in a superheavy syllable. Consequently, a superheavy syllable is always stressed, as illustrated in (20).[18]

(20)	Input:	EM:	Build Feet:	End Rule:	Output:
				*	
			*	(*)	
	μ μ μ μ	μ μ μ<μ>	μ (μ μ)<μ>	μ (μ μ)<μ>	
	kata b t	kata b t	kat a b t	kat a b t	*katábt*

The Cairene Arabic data motivate the moraic trochee because it alone allows for all of the attested stress patterns to be accounted for by a single set of rules. The syllabic trochee cannot be used because stress assignment is sensitive to syllable weight. Likewise, an analysis utilizing the iamb would incorrectly predict that all feet are right-headed, which is inconsistent with forms such as *búxala* and *shàjarátun*.

To summarize thus far, the stress patterns of Warao and Cairene Arabic exemplify Hayes' syllabic trochee and moraic trochee, respectively.

To complete the discussion of Hayes' inventory of primitive feet, I next consider the iambic stress pattern of Hixkaryana, a Carib lan-

---

[18] (20) assumes, following McCarthy and Prince 1990, that a final consonant is moraic but extrasyllabic. One might also hypothesize that the final consonant of *katabt* has no mora of its own but is instead adjoined either to the final mora or the final syllable. If this were the case, then the extrametricality rule in (11a) would need to be stated differently so as to make both moras of the final syllable visible to foot-building.

guage of northern Brazil (Derbyshire 1985, Hayes 1991). Stress in Hixkaryana occurs on closed syllables and on the nonfinal even members of a string of open syllables. Stressed vowels in open syllables are lengthened, but there are no instances of underlying vowel length. Sample data follow:[19]

(21) Hixkaryana:

khaná:nɨ́hno	*I taught you*
mɨhá:nanɨ́hno	*You taught him*
ówtohó:na	*to the village*
tóhkurʸé:hona	*to Tohkurye*
tóhkurʸé:honá:hašá:ka	*finally to Tohkurye*

Hayes accounts for the above distribution of stress by constructing iambic feet from left to right. Since stress never occurs on the final syllable, he assumes a rule which renders the final syllable (or mora, since word-final syllables are always monomoraic) extrametrical. This is illustrated below:

(22) Input: Extrametricality:

```
   σ     σ    σ    σ    σ            σ     σ    σ    σ   <σ>
  /|\   /|   /|   /|   /|           /|\   /|   /|   /|   /|
 t o h k u rʸe h o n a             t o h k u rʸe h o n a
```

Build 1st Foot: Build 2nd Foot: Output:

```
   *                                  *          *
  (σ)    σ    σ    σ  <σ>            (σ)   (σ    σ)   σ  <σ>
  /|\   /|   /|   /|  /|             /|\   /|   /|   /|  /|
 t o h k u rʸe h on a               t o h k u rʸe h on a      tóhkurʸé:hona
```

[19]Following Hayes 1991, I use Derbyshire's practical orthography with the addition of stress marks based upon Derbyshire's description.

Thus, the grammar of Hixkaryana constructs iambic feet iteratively from left to right. Hayes attributes the lengthening of stressed vowels in non-final open syllables to the fact that the grammar calls for iambic feet.

In summary, Hayes' 1987, 1991 theory is able to account for a wide range of stress patterns using only three primitive metrical feet -- the syllabic trochee, the moraic trochee and the iamb -- plus a general prohibition against degenerate feet. Hayes' theory provides a basis for the new theory of stress that is proposed in chapter 2.

Next, I discuss the theory of lexical phonology as it applies to this study.

1.2.3. Cyclic Linking and Delinking.

Chapter 3 demonstrates that the Mayo lexicon distinguishes between *accented* roots, which contain a floating lexical stress autosegment, and *unaccented* roots, which lack this autosegment. Evidence for the floating status of the stress autosegment comes from the observation that stress always ends up on the very first vowel of an accented word regardless of its morphological composition, whereas second syllable stress is consistently observed in unaccented words. Chapter 5 argues that the reduplicative base is a disyllabic foot for unaccented words but only a syllable for accented words.

In order to account for the above set of observations, it is necessary to make some minimal assumptions regarding the manner in which morphology interacts with phonology. Therefore, I adopt the following

principles which are based largely on the work of Kiparsky 1973, 1979, 1982, 1985, Mohanan 1982, 1986 and Halle and Vergnaud 1987a and b.[20] First, I assume that each morphological operation triggers the application of a set of phonological rules.[21] Second, if a phonological rule is available at one point in the derivation, then it is also available at all earlier stages of the derivation (i.e., it applies at any of those stages if its structural description is satisfied). Third, a grammar may permanently 'turn off' a phonological rule at any point in the derivation.[22]

Applying the above three principles to Mayo, I argue for the following analysis in chapter 5: The floating stress autosegment of accented words links by rule from left to right at the beginning of a cycle (i.e., immediately following any morphological operation) and undergoes a delinking rule at some later point in the same cycle; this process is repeated in each cycle.[23] The linking rule never gets turned off (i.e., it is both lexical and post-lexical), but the delinking rule

---

[20]Many of the issues that are debated in these works are not crucial to the analysis of the Mayo data. I discuss here only those principles of lexical phonology which are needed in order to account for the Mayo data in chapters 3 and 5. Some of these principles are also needed in order to account for the facts of Tagalog stress in section 5.3.

[21]Of course, each rule applies only if its structural description is met. Since all Mayo affixes appear to be cyclic, I do not address the formal distinction between cyclic and non-cyclic morphemes that appears to be operative in some other languages such as Russian and Sanskrit (Halle and Vergnaud 1987a and b).

[22]See Myers 1991b for specific arguments for the latter two claims, known collectively as the *Strong Domain Hypothesis*.

[23]Pulleyblank 1986 (pages 114-16) argues that a delinked tone cannot relink during the same morphological cycle in which it was delinked. Indeed, section 5.1.2 demonstrates that the facts of Mayo stress and reduplication require that linking be ordered before delinking and that both rules be cyclic. Thus, the use of delinking and relinking in the analysis of Mayo stress is consistent with Pulleyblank's results.

is 'turned off' at the end of the lexical phase of the phonology (i.e., after all word-level morphological processes have applied). As a result, a lexical accent is always linked to the leftmost stress-bearing unit at the end of a derivation. Finally, I argue that the application of foot-building to an accented (i.e., already-stressed) stress-bearing unit produces a degenerate foot rather than the usual binary foot. The empirical basis for this latter claim is presented in section 5.1.2.

Given this set of assumptions, the facts of stress and reduplication in Mayo are readily accounted for. The above scenario does not introduce anything that is not already found in autosegmental theory except for the claim that a linked accent affects the output of foot-building by forcing a degenerate foot to be built instead of the usual binary foot. Section 5.1.2 argues that this claim (or its equivalent) is needed regardless of whether or not one assumes cyclic linking and delinking.

Next, the Obligatory Contour Principle is briefly defined and discussed. This principle is invoked in a number of the analyses that are presented in the remaining chapters.

1.2.4. The Obligatory Contour Principle.

The Obligatory Contour Principle (henceforth, *OCP)* was originally proposed in Leben 1973 in order to account for an observed asymmetry in the tonal system of Mende. As originally formulated, the OCP prohibits the occurrence of adjacent identical tones. McCarthy 1985 extended the application of this principle to the realm of segmental phonology,

claiming that adjacent identical phonological features of any kind are prohibited.

A number of arguments have since been raised against the OCP, most notably by Odden 1988. However, Archangeli 1985, Myers 1987 and Yip 1988a all note that virtually all of the objections to the OCP may be dismissed if the notion of adjacency is properly defined. In particular, they claim that the OCP prohibits the occurrence of two identical features in a representation only when the identical features are linked to adjacent structural nodes. This is illustrated in (23), where F is some feature and X is some structural node which is capable of being linked to F.

(23) (a) <u>Disallowed</u>: (b) <u>Allowed</u>:

```
(a)  * F  F          (b)  F     F
       |  |               |     |
       X  X               X  X  X
```

The crucial difference between (23a) and (23b) is that the two F-bearing X's are adjacent and hence illicit in (a) but not in (b). Archangeli 1985 argues for this view of the OCP based on the facts of vowel harmony in Nyangumarda, an Australian language, and Myers 1987 argues for the same view based on tonal processes in Shona.[24]

Furthermore, McCarthy 1979, 1981 and 1986, Halle and Vergnaud 1987a, b and Archangeli and Pulleyblank (in press) all claim that even the representation in (23a) may occur when the (superficially) adjacent

---

[24]For more extensive discussion of the OCP, see McCarthy 1986, Yip 1988a and Odden 1988 as well as a summary of each of these works in Goldsmith 1990, pages 309-18.

F-bearing X's are considered to be on separate morphemic tiers, as illustrated in (24).

```
(24)      F
          |
          X  X
             |
             F
```

This claim, known as the *Morphemic Plane Hypothesis*, is discussed briefly in section 2.2.3.

To summarize, the OCP prohibits adjacent identical elements within a given domain, but such adjacency is not prohibited if the identical elements are on different morphemic tiers. This view of the OCP is assumed throughout this study.

1.3. Outline of the Remainder of the Thesis.

As was mentioned earlier, the two central claims of this study are that (i) all feet are inherently headless and (ii) whenever stress is assigned to a foot, it is assigned via the principles of autosegmental theory. In order to demonstrate the first point, chapter 2 begins by defining the notion of *metrical head*. It is pointed out that, although the terms *metrical head* and *stress* do not have the same meaning, they have often been used interchangeably. The formal properties of each of these entities are then reviewed. It is argued that, since stress is the only diagnostic for the presence of a metrical head, the latter is redundant and must be eliminated from phonological theory. Stress cannot be eliminated in favor of metrical heads because stress can exist

without any corresponding metrical structure whereas metrical heads, by definition, presuppose the existence of metrical structure. Thus, although the existence of metrical heads cannot be disproven, they do not actually do anything other than duplicate one of the functions of stress, nor can they replace stress in those contexts which are devoid of metrical structure. It is concluded, therefore, that feet do not have heads. Further arguments for the inherent headlessness of feet are cited from the theory of prosodic morphology (McCarthy and Prince 1990, Crowhurst 1991b) as well as from the facts of Yidin^{y} stress (Dixon 1977, Crowhurst 1991a, Crowhurst and Hewitt, to appear).

Having thus argued that all feet are inherently headless, I then explore the hypothesis that stress is autosegmental by reviewing the properties of autosegments and comparing those properties to the previously-compiled list of the properties of stress. It is concluded that the formal behavior of stress is identical to the formal behavior of autosegments. That is, stress is an autosegment.

Chapter 2 concludes with the central proposal of this thesis, which is that stress assignment universally consists of the insertion and linking of a stress autosegment in feet and/or some other prosodic domain. The predicted typology of stress is briefly discussed. It is assumed that there are only three primitive feet; these differ from Hayes' three foot types only in that Hayes' feet are inherently headed whereas these are not. The combination of this inventory of primitive feet with the independent ability of grammars to assign stress to either edge of a foot produces the following inventory of stressed feet: left-

stressed syllabic, right-stressed syllabic, left-stressed moraic, right-stressed moraic and iambic. The total absence of stress systems which stress the weak member of an iambic foot is accounted for by the *Weight-to-Stress Principle* (Prince 1990), which overrides the otherwise-free ability of a grammar to combine any foot type with either direction of linking of the stress autosegment.

Three additional principles are formalized in order to complete the theoretical framework which is assumed and argued for in the ensuing chapters. These concern (i) the claim that stress autosegments may be inserted into any prosodic domain, including the foot, (ii) the manner in which lexically-specified stress interacts with the process of foot-building, and (iii) the claim that all stressed feet within any given word must, at all points in the derivation, agree with respect to which edge stress is linked to. The latter statement is concerned only with feet which have been assigned a stress; it makes no claim regarding stressless feet.

Chapter 3 instantiates the predicted typology of binary stress feet with data from Warao, Mayo, Cairene Arabic, Turkish and Hixkaryana. The first four of these languages exemplify the four logically possible surface combinations of a stress autosegment with a symmetric foot. The final language, Hixkaryana, is presented as an example of how the Weight-to-Stress Principle forces a stress autosegment to link to the stronger member of an asymmetric foot. The Weight-to-Stress Principle is then invoked to derive the stress pattern of Khalkha Mongolian, Huasteco and a number of other languages with so-called 'unbounded'

feet. Following Prince 1990, it is argued that foot structure is not attested in these languages, and that the Autosegmental Stress Hypothesis actually predicts all and only those 'unbounded' stress patterns which are attested.

The remainder of the thesis provides further arguments for the two key claims of the theory, i.e., that (i) stress and foot structure are logically separate and (ii) stress is autosegmental. Chapter 4 presents a detailed analysis of the facts of stress and vowel length in Yidin^y, a language of Australia, as evidence for the separation of stress and foot structure. Chapter 5 takes a closer look at Mayo and argues for the presence of floating accent in a number of Mayo words; similar evidence is presented for the existence of floating accent in Tagalog. Further evidence for the autosegmental nature of stress is deduced from base transfer effects in Mayo reduplication and from the interaction of segmental length and stress assignment in Mayo.

Chapter 6 suggests how the proposed theory might be extended to account for the occurrence of multiple degrees of stress as well as instances of 'long range' stress shift under clash. A potential objection to the autosegmental theory of stress is also discussed. This concerns the observation that stress autosegments never seem to undergo the autosegmental process of spreading. It is suggested, as a preliminary explanation, that stress cannot undergo spreading because to do so would conflict with its central function of setting off one element in a representation as more prominent than all the others.

In summary, this study is an attempt to account for all stress-related phenomena in terms of principles and devices which are independently required outside the realm of stress. Two major conclusions are reached: (i) feet are inherently headless and (ii) stress is autosegmental. These conclusions are reinforced by the facts of stress in a wide variety of languages.

CHAPTER 2

THE SEPARATION OF STRESS AND METRICAL STRUCTURE

As was stated in chapter 1, the two central claims of this study are that (i) all feet are inherently headless and (ii) whenever stress is assigned to a foot, it is assigned via the principles of autosegmental theory. This chapter summarizes the various kinds of evidence, both theoretical and empirical, for these claims and presents the principles which form the basis for the remainder of the thesis.

With regard to the first claim, the concept of headless feet is not new to the theory presented here. The possibility of headless metrical feet is built into the formalism of Halle and Vergnaud 1987a and b (henceforth, *H&V)* by virtue of the fact that their rules of constituent construction make no direct reference to heads. Rather, the assignment of heads to feet is handled by a separate rule or set of rules ordered after the rules which generate feet. Since the assignment of heads is explicitly ordered as a separate rule following the construction of feet, there exists a point at which feet are headless. H&V apparently assume that these headless feet are inaccessible to individual grammars; this point is developed in section 4.3.2. Nevertheless, assuming that grammars are free to select some rules and omit others, H&V's formalism predicts that a language might have a rule generating feet but no rule assigning heads to those feet.

Halle and Idsardi 1992 are even more explicit in separating metrical heads from foot-building. For example, they use the term *linking* to relate metrical heads to feet. However, all heads are derived from

metrical structure in Halle and Idsardi's theory, whereas in my theory heads are completely replaced by stress, which is formally independent of metrical structure.

Additional arguments for the inherent headlessness of feet are presented in Crowhurst 1991b. In particular, she demonstrates that the feet used in prosodic morphology are necessarily headless. However, she argues for a stage in the derivation of stress during which heads are assigned to feet, whereas I argue in this chapter that metrical heads are never required.

In order to demonstrate that all feet are inherently headless, section 2.1 begins by defining the notion of *metrical head* and then points out that the latter is always interpreted phonetically as stress, i.e., stress is the only diagnostic for the presence of a metrical head. Next, it is argued that the concept of metrical head cannot be the sole formal representation of stress because there are numerous languages in which stress can exist without any corresponding metrical structure. It is concluded, therefore, that some kind of formal representation of stress is needed independently of the representation of metrical heads. This raises the following question which is central to this thesis: can stress, as a formal representation, take over the job of metrical heads? The ensuing sections of this chapter demonstrate not only that the answer is yes, but also that several useful results follow from this move. One of these is that the number of linguistic primitives is reduced in that, whereas most generative theories of stress up until now have assumed the existence of metrical heads, these can now be elimi-

nated. Since stress is needed as a primitive independently of metrical heads, no new primitives are added, and the total number of primitives is reduced by one under the theory proposed here.

To summarize, although the existence of metrical heads cannot be disproven, section 2.1 argues that they entirely duplicate one of the functions of stress and are unable to replace stress in those contexts which lack metrical structure. It is concluded, therefore, that feet are universally headless.

Next, two arguments are then presented in support of the claim that feet can exist apart from stress. These arguments are based on the theory of prosodic morphology (McCarthy and Prince 1990) and the facts of Yidin^y stress (Dixon 1977, Crowhurst 1991a, Crowhurst and Hewitt, to appear), respectively.

Having thus eliminated the notion of *metrical head* and concluded that stress and foot structure are logically independent of one another, section 2.2 explores the hypothesis that stress is autosegmental. The properties of stress are reviewed, followed by an examination of the properties of autosegments. These two sets of properties are then compared. After eliminating those differences which pertain only to phonetic substance and not to formal behavior, it is concluded that the formal behavior of stress is identical to the formal behavior of autosegments. That is, stress is an autosegment.

The remainder of the chapter presents the basic proposal of this thesis, which is that stress assignment universally consists of the insertion of an autosegment into feet and/or some other prosodic domain.

The predicted typology of stress is briefly discussed in two stages. First, it is argued that there are only three primitive (i.e., stressless) feet. These are the syllabic foot, which consists of two syllables, the moraic foot, which consists of two moras, and the iambic foot, which consists of Hayes' iamb (see figure 2 in chapter 1) with the exception of being headless. Second, the combination of this inventory of primitive feet with the independent ability of grammars to assign stress to either edge of a foot produces the following inventory of stressed feet: left-stressed syllabic, right-stressed syllabic, left-stressed moraic, right-stressed moraic and iambic. The asymmetry of iambic systems is accounted for by the *Weight-to-Stress Principle* (Kager 1989, Prince 1990), which overrides the independent ability of grammars to assign stress to either edge of a domain. The instantiation of each of these stress types is postponed until chapter 3.

Finally, four principles are formalized in order to complete the theoretical framework that is assumed and argued for in the ensuing chapters. These include the following. First, the *Foot-as-Domain Principle* states that stress autosegments may be inserted into any prosodic domain. In particular, it is claimed that the foot serves as a domain for autosegmental operations in stress systems in essentially the same manner as the word serves as a domain for autosegmental operations in grammars that do not utilize feet. Second, the aforementioned Weight-to-Stress Principle is formalized. Third, the *Degenerate Foot Principle* concerns the interaction of lexical accent with the process of foot-building. Based on data from Mayo, a Uto-Aztecan language of Mexico, it

is argued that the presence of a lexical accent linked to any element that is being incorporated into a foot forces that foot to become degenerate. Finally, the *Uniform Linking Constraint* (based on the *Uniform Headedness Constraint;* see Halle and Vergnaud 1978, Stowell 1979, Hammond 1990b) states that all stressed feet within any given word must agree as to which edge the stress autosegment is linked to at all points in the derivation.

I begin with a discussion of the formal relationship between stress and metrical structure.

2.1. Defining the Relationship Between Stress and Metrical Structure.

This section argues for two distinct claims: (i) that the concept of *metrical head* must be eliminated from phonological theory, and (ii) that feet are always constructed without stress. In order to argue that metrical heads are never required, it is first necessary to define what is meant by the term *metrical head.* Therefore, this section begins with a review of the formal properties that have been attributed to metrical heads. A distinction is drawn between the purely theoretical notion of *metrical head* and the more descriptive term *stress.* It is argued that the role of metrical heads is redundant because the latter are always realized as stress, and yet stress may be shown to exist in contexts which arguably lack metrical heads. Next, metrical heads are shown to be absent from the feet that are utilized in prosodic morphology. Finally, I briefly discuss the use of headless feet in the stress system of Yidin^y. Having thus argued that the concept of a metrical

head lacks empirical motivation, it is concluded that all feet are inherently headless.

Next, I address the relationship between stress and feet. Two kinds of evidence are reviewed for the claim that feet are always constructed without stress. The first of these concerns the nature of the feet that are used in prosodic morphology (McCarthy and Prince 1986, 1990, Crowhurst 1991b); the second concerns the interaction of metrical structure and stress in Yidin^y (Halle and Vergnaud 1987b, Hammond 1987b, Crowhurst 1991a, Crowhurst and Hewitt, to appear).

I turn first to the following questions: what is a metrical head, and is such a concept actually required?

2.1.1. The Elimination of Metrical Heads.

The concept of a *metrical head,* which is sometimes referred to as a *strong position,* has been utilized quite freely in the study of stress systems. (See, for example, Liberman and Prince 1977, Kiparsky 1979, Hayes 1981, 1982a, b, 1987, 1991, Hammond 1985, 1986, 1988a, b, 1990b, Halle and Vergnaud 1987a and b, to name but a few). Nevertheless, very little effort has been devoted to isolating the formal properties of metrical heads. Two notable exceptions to this are Kager 1989 and Crowhurst 1991b. Kager defines a metrical head as a syllable which is the target of *Syllable Adjunction,* a rule which creates binary metrical

feet.[1] Thus, for Kager, a metrical head is defined solely in terms of its role in the rule of Syllable Adjunction.

Crowhurst 1991b defines a metrical head in a manner which might seem different from Kager's but which is in fact functionally equivalent to it. Following Hayes 1981, 1982a, 1987 and 1991, Crowhurst states that 'the metrical head is a constituent required by and dependent on (i.e., occurring uniquely within) the metrical foot' (page 44). Thus, Crowhurst's theory, like Kager's, views the head as an obligatory element of a metrical structure.[2] For Crowhurst, that metrical structure is a foot which may or may not be binary, while Kager avoids the term *foot* but nevertheless creates the equivalent of a binary foot via his rule of Syllable Adjunction. In both theories (as well as that of Hayes), a metrical head is entirely dependent upon a metrical foot (or the equivalent) for its existence.

---

[1]As a consequence of this aspect of his theory, Kager proposes the *Strict Binarity Hypothesis*. My proposal is less strict than Kager's in that I argue for the presence of degenerate feet in certain Mayo words. I differ most significantly from Kager in that I do not require stress to be associated with foot structure; this is explained below.

[2]Crowhurst also claims that a metrical head is a template, so that a grammar may require the head to be either bimoraic or monomoraic, independently of the requirements on the foot itself. Crowhurst uses this approach primarily to explain why the feet used in stress systems can sometimes be degenerate while the feet used in morphological processes are always binary. However, Crowhurst's arguments for the templatic nature of the head depend crucially upon the assumption that the presence of stress implies the presence of a foot. As Prince 1990 points out, there are arguments against this assumption in unbounded stress systems. Since it is not clear that the foot is independently motivated in the crucial examples that Crowhurst cites as arguing for the templatic nature of the head, I view the latter as an untested hypothesis.

In contrast to the above theories, each of which defines a metrical head as an obligatory element of a metrical structure, I claim that metrical structures are inherently headless. The basic argument for this claim is based on the observation that the presence of the language-particular feature or set of features which we refer to as *stress* (i.e., tone, length and/or volume) is the only available diagnostic for the presence of a metrical head. (For studies in the phonetics of stress, see Fry 1955, 1958, Lehiste 1970, Liberman 1975 and Pierrehumbert 1980). That is, to my knowledge, no one has ever posited the existence of an abstract metrical head in surface representation apart from the existence of a corresponding non-abstract stress. Furthermore, in those instances where metrical heads are generated at intermediate stages of the derivation in positions which eventually surface without stress, some kind of mechanism must always be invoked by which those metrical heads are deleted. For example, Halle and Vergnaud 1987a and b create the device of *conflation* for the express purpose of eliminating excess metrical heads. Conflation has the effect of eliminating all but the most prominent metrical head in a representation.

Thus, there is no empirical evidence for the existence of metrical heads apart from the existence of stress itself. On the other hand, there are at least two arguments for the existence of stress apart from metrical heads. The first line of reasoning comes from Prince 1983, 1990, who points out that there are many occurrences of stress for which there is arguably no corresponding metrical structure (and hence no corresponding metrical head). Prince's argument focuses on the observation

that stress in some languages is assigned to heavy syllables without regard for how close they occur to the edge of the representation. This class of stress system, which Hayes 1981, 1987 and 1991 refers to as *unbounded quantity sensitive*, is exemplified in Khalkha Mongolian, Yana, Aguacatec Mayan, Huasteco, Eastern Cheremis, Komi, Waalubal, Koya and Western Greenlandic Eskimo; each of these is described in Hayes 1981.

For example, in Huasteco, the final long vowel of the word gets stressed; if there are no long vowels in a word, then the first vowel is stressed. Representative data are given in (1).

(1) <u>Huasteco</u> (Larsen and Pike 1949):

?á:šušlom	*field of garlic*
k^w'ahí:lom	*widow*
?alabé:l	*pretty*
hu:čú:k'čik	*blisters*
bi:nomá:c	*one who gave*
e:la:šwá:y	*(they) surely find each other*
cabá:l	*earth*
cábal	*cooked corn*
?át'em	*salt*
cálam	*shade*
k^w'áθap	*tarantula*
hílk'omač	*leftovers*

Notice that some of the words in (1) contain sequences of two stressless syllables, and the location of each of these sequences of stressless syllables is determined only by the location of the first long vowel. Because Hayes 1991 assumes the Bijectivity Principle, which claims that there is a one-to-one correspondence between metrical heads and metrical feet, he is forced to conclude from these facts that the grammar of Huasteco (as well as the grammars of the other languages mentioned earlier) constructs unbounded feet, i.e., feet which may contain

any number of syllables. For example, the theory of Hayes 1991 parses *ʔá:šušlom* as a single left-headed foot consisting of three syllables, as illustrated below.

```
(2)     *
       (*   *   *)
       ?a:šušlom
```

The problem with Hayes' theory is that unbounded feet, if they exist, should be available to function in templatic morphological processes such as reduplication, just as binary feet have been observed to do. An example of such a process using unbounded feet would be a morphological rule which copies everything up to and including the first heavy syllable of a stem. Since such processes appear to be unattested, I follow Prince in concluding that unbounded feet do not exist. (For additional arguments against the existence of unbounded feet, see Hammond 1990b). Instead, I assume that stress assignment is achieved in languages such as Huasteco via the *Weight-to-Stress Principle*, stated below.

(3) Weight-to-Stress Principle (Kager 1989, Prince 1990): If heavy, then stressed.

The Weight-to-Stress Principle simply means that, in some languages, stress is assigned directly to heavy syllables without the use of feet. Since words which lack heavy syllables are nevertheless stressed on a peripheral syllable in Huasteco as well as in all other languages with unbounded stress, the Weight-to-Stress Principle must be supplemented

with the End Rule (Prince 1983, pages 73-79). The Weight-to-Stress Principle is discussed and illustrated in sections 2.3.3.2 and 3.2.

The point of the above discussion is this: since there is no instance of a morphological process which utilizes unbounded feet, and since unbounded stress systems such as that of Huasteco may be accounted for without feet by appealing to the Weight-to-Stress Principle and the End Rule, I conclude with Prince 1983 (pages 73-79) and 1990 that unbounded feet do not exist. Consequently, those languages which exhibit unbounded stress instantiate the existence of stress apart from feet. But since feet are not present in unbounded stress systems, then metrical heads, by virtue of their inherent dependence upon feet, cannot be present either. This constitutes the first argument for the existence of stress apart from metrical heads.

The second argument is based on the observation that, in many languages such as Spanish (Harris 1983), the location of stress is unpredictable in certain words. That is, even though a language may have a set of rules by which stress is normally assigned, there may be some words whose stress patterns are not derivable from those rules. In order to account for the exceptional stress patterns of these words, it is necessary to assume that they have a stress (or some element which would derive its exceptional location) already present in underlying representation.

As an alternative to using lexical stresses (henceforth, *lexical accents)* to mark exceptional stress, one might imagine marking an entire foot in underlying representation. This will work for some languages.

However, as Michael Hammond (personal communication) points out, there are a few languages in which exceptional stress can be accounted for only with lexical stresses and not with lexical feet. For example, Macedonian has regular antepenultimate stress as well as a few words which are exceptionally stressed on either the penult or final syllable (Lunt 1952, Comrie 1976, Franks 1983, Halle and Vergnaud 1987b, Hammond 1989b). Examples are given below.

(4) Macedonian Stress:

(a) Regular Antepenultimate Stress:

vodéničar	*miller*
vodéniča	*mill*
pólkovnik	*colonel*
rábota	*work*
véčer	*evening*
zbór	*word*

(b) Exceptional Penult and Final Stress:

konzumátor	*consumer*
literatúra	*literature*
komunízam	*communism*
autobús	*bus*
citát	*quotation*
restorán	*restaurant*

Comrie 1976 points out that, whenever one or more syllables are suffixed to a word with penultimate stress, it exhibits regular antepenultimate stress. Likewise, whenever one syllable is suffixed to a word with final stress, it exhibits penultimate stress, and following further suf-

fixation it exhibits regular antepenultimate stress. This is illustrated below.[3]

(5)	konzumátor	konzumátor-i	konzumátor-ot	konzumatór-ite
	autobús	autobús-i	autobús-ot	autobús-ite

As H&V point out, in order to account for regular antepenultimate stress, it is necessary to assume that a final syllable is marked extrametrical by rule except when that syllable bears a lexical accent. Maximally binary, left-stressed syllabic feet are then built from right to left, and all but the rightmost stress is subsequently eliminated via conflation, as shown below. Here (and henceforth), each stress-bearing unit is represented by an asterisk above the appropriate segment, and stress (whether lexical or derived) is represented by an additional asterisk placed above the appropriate lower level asterisk.

```
(6)  Underlying:         Extrametricality:     Build 1st Foot:

                                                  *
      * * * *             * * *<*>              *(* *)<*>
     vodeniča            vodeniča              vodeni ča

     Build 2nd Foot:     Build Word Tree:      Conflation:        Output:

                                *                    *
      *   *              (*   *)               (.   *)
     (*)(* *)<*>         (*)(* *)<*>            * (* *)<*>
     vo deni ča          vo deni ča            vo deni ča         vodénica
```

---

[3]The forms in (4) are basic citation forms, i.e., singular, without article and, for adjectives, masculine gender. In (5), the *-i* suffix represents plural without an article, the *-ot* suffix represents singular articulated and the *-ite* suffix combination represents plural articulated.

In the case of a word with penultimate stress, extrametricality must apply because the final syllable is unaccented. The presence of accent on the penult forces a degenerate foot to be built, as illustrated below.[4]

```
(7)  Underlying:            Extrametricality:       Build 1st Foot:

           *                      *                      *
       *   * * *              *   * *<*>             *   *(*)<*>
       konzumator             konzumator             konzuma tor
```

The above analysis produces regular antepenultimate stress in a suffixed form of *konzumátor*, as illustrated below.

```
(8)  Underlying:            Extrametricality:       Build 1st Foot:

           *                      *                      *
       *   * * * *            *   * * *<*>           *   *(* *)<*>
       konzumatori            konzumatori            konzumato ri
```

Exceptional final stress is derived as follows:

```
(9)  Underlying:            Extrametricality:       Build 1st Foot:

         *                                               *
       *  * *                                        *   *(*)
       autobus                Blocked by accent      autobus
```

When one or two suffixes are added to a form with final stress, the derivations are the same as in (7) and (8), respectively. Thus, lexical accent is able to account for all of the instances of exceptional stress in Macedonian.

[4] I illustrate only that portion of H&V's analysis which is relevant to the discussion at hand. For the full account of their analysis, see Halle and Vergnaud 1987b, pages 55-56.

There is no way, however, to account for Macedonian exceptional stress in a principled manner if lexical accents are replaced with lexical feet. In particular, suppose a word such as *autobús* were represented with an underlying final degenerate foot. Following the addition of two suffixes, such a word would be predicted to have penultimate stress rather than the attested antepenultimate stress. This is illustrated below.

```
(10) Underlying:          Suffixation:           Extrametricality:

          *                    *                      *
     *   *(*)             *   *(*)  *  *          *   *(*)*<*>
     autobus              autobus-ite            autobusite

     Build 1st Foot:      Output:

          *  *
     *   *(*)(*)<*>
     autobu si te         *autobusíte   (Should be autobúsite)
```

The problem in (10) lies in the assumption that an entire foot is present in underlying representation (with the added assumption that such a foot cannot expand during the course of a derivation). In contrast, no such problem is encountered when lexical accent is used to represent exceptional stress. I conclude, therefore, that lexical accent is required at least for Macedonian. Thus, exceptional stress in Macedonian instantiates the claim that there are some situations in which a stress is present in the derivation and yet it does not belong to a foot.

Another alternative to lexical accent is the use of lexically-specified foot boundaries. This is proposed in Halle 1990 as well as in Halle and Idsardi 1992. However, they use these foot boundaries in a

manner that is notationally equivalent to using lexical accent, for they allow only one of a foot's two boundaries to be underlyingly present in any given representation. The presence of a single foot boundary forces stress to occur on a particular neighboring stress-bearing unit whose location is determined by the setting of the headedness parameter and by whether the lexical boundary is a right or left bracket. Hence, this approach does not constitute the use of underlying feet any more than does a theory which uses lexical accent.

The above argument against the use of underlying feet is further supported by the fact that morphological processes should be able to access lexical feet, if they exist, and yet this type of phenomenon has never been reported. In other words, if feet could be present in underlying representation, then we would expect to observe these exceptional feet in morphological processes such as reduplication. The apparent absence of such phenomena supports the claim that all feet are derived by rule. Consequently, idiosyncratic stress has to be attributed to stresses that are present (without any corresponding feet) in underlying representation.[5]

To summarize the foregoing discussion, I have presented two arguments for the existence of stress apart from metrical heads. First, since feet are not present in unbounded stress systems, then metrical heads, by virtue of their inherent dependence upon feet, cannot be present either. Second, the facts of exceptional stress in Macedonian re-

[5]Certain aspects of Mayo reduplication in certain words are idiosyncratic. However, chapter 5 argues that these effects are caused by a lexical accent rather than an underlying foot.

quire the use of underlying stresses. Underlying feet cannot be used in Macedonian, nor has any morphological evidence been found for the existence of underlying feet.

A third argument for the existence of unfooted stresses is based on the (superficially) complex interaction of stress and length in Mayo. In order to avoid a long digression from the topic at hand, however, the full discussion of these facts is deferred until section 5.2.1.1.

Now, given that metrical heads have no phonetic correlate other than stress, and given that stress is not dependent upon the presence of a metrical head, there is no reason to include metrical heads in representations of metrical structure.[6] I conclude, therefore, that metrical heads are redundant and should be eliminated from phonological theory.

A potential counter-argument must be addressed at this point. Recall from section 1.2.2 that one of the properties of Hayes' iambic foot is that its non-head, if it has one, must be light. (Recall that all feet have inherent heads in Hayes' theory). This property, coupled with the requirement that an iambic foot be 'right-headed', means that the

[6]Recall from section 1.2.2 that there is some disagreement over the question of whether or not Cairene Arabic exhibits secondary stress. Hayes 1991 claims that metrical heads are attested in all the places where they are predicted by his theory, which includes non-final feet. The basis for this claim comes not from the existence of phonetic features of stress in non-final feet (for this is in dispute), but rather from the fact that a 'stressless' vowel on the left edge of a foot fails to undergo a phrasal syncope rule which would otherwise apply. If these 'metrically strong' vowels should turn out to bear no stress features whatsoever, then they would constitute a potential counter-argument to my claim that metrical heads do not exist. If, however, they exhibit some kind of concrete phonetic features, then they do not constitute a counter-argument to my claim. This question does not appear to be answered in the existing literature on Cairene Arabic stress.

foot-building algorithm has to evaluate the weight of each potential 'non-head' before it can decide where to place the next foot boundary. For example, if a grammar contains a rule which builds iambs from left to right, then it will parse a string in the following manner. Since 'non-heads' always have to be the leftmost member of an iamb, the foot-building rule will begin by examining the weight of the leftmost syllable in the string. If that syllable is light, it will become a 'non-head' and the next syllable, regardless of its weight, will become the 'head' of that same foot, as illustrated below.

(11) 1st σ Light, 2nd σ Light: $\mu\ \mu \longrightarrow (\mu\ \overset{*}{\mu})$

1st σ Light, 2nd σ Heavy: $\mu\ \mu\mu \longrightarrow (\mu\ \overset{*}{\mu\mu})$

If, however, the leftmost syllable is heavy, then it cannot become a 'non-head.' Instead, that syllable will be the 'head' of a foot and the next syllable will start a new foot regardless of its weight, as shown below.

(12) 1st σ Heavy, 2nd σ Light: $\mu\mu\ \mu\ \mu \longrightarrow (\overset{*}{\mu\mu})\ (\mu\ \overset{*}{\mu})$

1st σ Heavy, 2nd σ Heavy: $\mu\mu\ \mu\mu\ \mu \longrightarrow (\overset{*}{\mu\mu})(\overset{*}{\mu\mu})\ \mu$

If parsing is from right to left instead of left to right, foot boundaries will still be determined on the basis of the requirement that 'non-heads' be light. In this case, the rightmost syllable in the string will become the 'head' of a foot regardless of its weight, and the next syllable will be incorporated as the 'non-head' of that same

foot if and only if it is light; otherwise it will become the 'head' of a new foot:[7]

(13) Final σ Heavy, Penult σ Light: Final σ Heavy, Penult σ Heavy:

$$\mu\ \mu\ \mu\mu \longrightarrow \mu\ (\overset{*}{\mu}\ \mu\mu) \qquad\qquad \mu\ \mu\mu\ \mu\mu \longrightarrow (\overset{*}{\mu}\ \mu\mu)(\overset{*}{\mu\mu})$$

Notice that, regardless of the direction of parsing, it is the *'non-head'* rather than the 'head' which determines where foot boundaries will occur in an iambic foot. What, then, does this reveal about the nature of asymmetric feet? It tells us that asymmetric feet include, as part of their set of defining characteristics, a condition on one of their terminal elements. The specific condition for iambic feet is that the leftmost of two terminal elements be light. This is a condition that is placed on foot-building independently of the placement of stress and, hence, without requiring any reference to the concept of a metrical head. Thus, although it might at first glance appear to be otherwise, Hayes' definition of the iambic foot does not entail the admission that feet have heads.

In conclusion, the theories of Hayes, Kager and Crowhurst all assume that the metrical head is an obligatory element of a prosodic structure, but I have argued that metrical heads must be eliminated for the following reason. Since stress is the only diagnostic for the presence of a metrical head, it must be the case that one of these entities is unnecessary. Stress cannot be eliminated in favor of metrical heads,

[7]Actually, according to Hayes' theory the sequence $\mu\mu\ \mu$ will end up as $(\mu\mu)\mu$ rather than $*(\mu\mu)(\mu)$ because of the ban on degenerate feet.

for stress can exist independently of metrical structure; this is evidenced by the absence of feet in unbounded stress systems plus the observation that stress, but not metrical structure, can exist in underlying representation.

Because of this asymmetric dependency relationship between metrical heads and stress, I consider all feet to be headless. Consequently, feet are henceforth depicted simply as domains in which phonological operations may apply. Section 2.3.3.1 develops the latter claim, which I refer to as the *Foot-as-Domain Principle*.

The foregoing discussion settles the question of whether or not feet have heads, but it also raises the following question: Given that stress is not dependent upon metrical structure for its existence, is metrical structure somehow dependent upon stress? That is, can feet exist apart from stress? This question has already been answered by McCarthy and Prince 1990; the next section reviews their arguments.

2.1.2. The Evidence for Stressless Feet.

Recall that the purpose of this chapter is to demonstrate, first, that feet are inherently headless and, second, that stress is autosegmental. The preceding section focused on the arguments for the claim that feet are headless. Now, in order to demonstrate that stress is autosegmental, several points must be demonstrated. First, it must be shown that stress can exist apart from metrical structure; this was already done in the preceding section in the process of arguing for the inherent headlessness of feet. Second, it must be shown that metrical

structure can exist apart from stress; this is the topic of the present section. Section 2.2 argues for the final point, which is that the observed behavior of stress is consistent with what is known about autosegments, and vice versa.

What are the arguments, then, for the claim that feet can exist independently of stress? This section reviews two kinds of evidence for this claim. The first line of evidence comes from the realm of prosodic morphology and the second concerns the interaction of stress and length in Yidin^y, a language of Australia. These are presented in sections 2.1.2.1 and 2.1.2.2, respectively.

2.1.2.1. Stressless Feet in Prosodic Morphology.

This section argues that metrical constituents (i.e., feet) can exist without stress. The basis for this argument comes from the theory of prosodic morphology as developed in McCarthy 1981, McCarthy and Prince 1986, 1987 and 1990 (henceforth, *M&P*). This theory is concerned not with stress but rather with the interaction between prosodic structure (particularly the mora, the syllable, the foot and the prosodic word) and morphology. Since M&P's theory examines feet from a different perspective using data that are somewhat different from the data which are addressed by theories of stress, one might well expect it to shed new light on the nature of stress assignment. This is in fact suggested but not pursued in McCarthy and Prince 1990. Crowhurst 1991b makes extensive use of M&P's theory in separating foot-building (which she formalizes as inserting, associating and projecting a foot) from stress

assignment. In Crowhurst's theory, however, stressed feet have heads and stress is not autosegmental.

How, then, does M&P's typology of morphological feet compare to the various typologies of stressed feet that have been proposed? It turns out that the inventory of morphological feet is essentially identical to the inventory of Hayes' stressed feet except for one striking difference. All of Hayes' stressed feet have heads which surface as stress, while the feet of prosodic morphology exhibit no evidence of having heads or stress except in those cases where stressed feet and morphological feet are coterminous.

One might be tempted to dismiss this apparent difference by claiming that morphological feet *do* in fact have heads which they simply never make use of except when the same feet are used for both morphology and stress. However, there are two problems with this claim. First, the preceding section argued that heads are not needed even for stressed feet. Second, the claim that morphological feet have heads incorrectly predicts that grammars should be able to refer to those heads. For example, in Hayes' theory stress is assigned to metrical heads (although the preceding section argued that those heads are redundant). In the case of purely morphological feet, there are no rules which refer to the heads of these feet. If it is true that morphological feet have heads, then the complete absence of rules referring to these heads remains unexplained.

Thus, it cannot be the case that morphological feet have heads, and yet Hayes' theory (like many others) assumes that heads are present

in stressed feet. The theory of M&P handles this discrepancy by proposing that stressed feet and morphological feet are in fact two different entities, each subject to the same set of principles and parameters but nevertheless having different functions and therefore capable of operating independently of one another. Following this same approach, Hammond 1989a argues that the type of foot used in morphological processes, which he terms the *parsing foot*, is also used in certain purely phonological processes. Under this view, the observation that some feet seem to be headless while others have heads has a functional explanation: Stressed feet need heads and parsing feet don't need heads. However, the many apparent similarities between these two classes of feet are simply accidental, and Hammond's solution essentially creates the new binary parameter *[stress foot/parsing foot]*. Before such a solution can be accepted as valid, it must be shown that there is no way to relate these two nearly-identical entities in terms of independently needed principles and/or parameters.

Crowhurst 1991b solves this problem by arguing for the separation of foot-building from stress assignment. Given this separation, the difference between parsing feet and stressed feet finds a principled explanation: both kinds of processes utilize the same set of feet, but stress assignment involves performing operations on or in those feet.

This aspect of Crowhurst's proposal is the starting point of the present study; I differ from Crowhurst 1991b in terms of the approach to stress assignment but not in the concept of separating foot-building from stress assignment.

In summary, the foot typology that is required in order to account for prosodic morphological processes is essentially identical to the typology which Hayes 1991 proposes for stressed feet, with one major difference: the feet that are used in morphological processes do not have heads. Following Crowhurst 1991b and contrary to Hayes 1991, I assume that stress systems make use of the same inventory of feet as that which is used in prosodic morphology. The surface differences between morphological feet and stressed feet are accounted for by processes which are distinct from foot-building.

One prediction stemming from this conclusion is that it should be possible for other phonological rules to intervene between the construction of feet and the assignment of stresses to those feet. The next section provides a brief overview of how such intervention is instantiated in the grammar of Yidin^{y}.

2.1.2.2. The Use of Stressless Feet in the Derivation of Yidin^{y} Stress.

The preceding section reviewed the arguments for the claim that heads are never needed in feet that are used for purely morphological processes such as reduplication. In order to counter any remaining objections to the broader claim that all feet are inherently headless, this section briefly examines the stress pattern of Yidin^{y}. Chapter 4 examines Yidin^{y} in more depth, but this section presents the crucial evidence for the claim that even metrical feet are initially constructed without heads.[8] The data are taken from Dixon 1977, and the arguments

[8] In independent work, Crowhurst 1991a and Crowhurst and Hewitt (to appear) arrive at this same conclusion on the basis of the same data.

are based upon the observations of Halle and Verganud 1987b, Sietsema 1989, Hammond 1989a and Hewitt 1990.[9]

Dixon 1977 gives the following generalization regarding the surface relationship between stress and vowel length in Yidin^{y}:

(14) <u>Stress Assignment Rule</u> (Dixon 1977):

> Stress is assigned to the first syllable involving a long vowel. If there is no long vowel, it is assigned to the first syllable of the word. Further stresses are then assigned (recursively) to the syllable next but one before, and the next but one after, a stressed syllable.

In order to see that stress assignment really is sensitive to the location of the first long vowel, consider first the examples in (15), where the second vowel is long. In each instance, only even-numbered syllables are stressed.

(15)	galí:n^{y}	*go-PAST*
	bulmbá:	*at the camp*
	bun^{y}á:n	*woman-GENITIVE*
	gudá:ga	*dog*
	yabú:lam	*loya cane*
	mad^{y}í:ndaŋ	*walk up- PRESENT*
	yad^{y}í:riŋál	*walk about-GOING-TRANSITIVIZER-PRESENT*
	wawá:lin^{y}ú	*see-GOING-PAST*
	d^{y}uŋgá:riŋá:lna	*run-GOING-TRANSITIVIZER-PURPOSIVE*

However, the aforementioned studies go on to assign heads to feet, whereas I argue that all feet are headless.

[9]Hewitt 1990 argues for the separation of feet and heads (which I would view simply as stress) not only in Yidin^{y} but also in Alutiiq (Pacific Yupik Eskimo). For the sake of brevity and because the Alutiiq data raise further issues that are beyond the scope of this work, I discuss only Yidin^{y}.

Now consider examples in which the third vowel is long. In each case, only odd-numbered syllables are stressed. Notice that the first example has the same stem as the first example in (15), but vowel length occurs on a different syllable in each instance. I return to this point below.

(16)	gáliŋá:d^{y}iŋ	*go-TRANSITIVIZER-ANTIPASSIVE-PRESENT*
	wúŋabá:d^{y}in^{y}únda	*hunt-ANTIPASSIVE-SUBORDINATE-DATIVE*

Now consider examples in which the fourth vowel is long. This time, only the even-numbered syllables are stressed.

(17)	ŋunáŋgará:	*in/on the whale*
	gulúgulú:y	*black bream-COMITATIVE*
	mad^{y}índaŋá:d^{y}iŋ	*walk up-TRANSITIVIZER-ANTIPASSIVE-PRESENT*
	gudágudá:ga	*dog-REDUPLICATED-ABSOLUTIVE*

Finally, the examples in (18) demonstrate that stress begins with the first vowel if the word contains no long vowels. Dixon observes that all such words contain an even number of syllables.

(18)	múd^{y}am	*mother-ABSOLUTIVE*
	wáṛil	*doorway-ABSOLUTIVE*
	mád^{y}indána	*walk up-PURPOSIVE*
	ŋúnaŋgára	*whale*
	d^{y}ámbuláŋaln^{y}únda	*two-VERBALIZER-SUBORDINATE-DATIVE*

Thus, Dixon's generalization is fully supported by the data: The surface distribution of stress is determined entirely by the surface distribution of vowel length. Notice, however, that the converse is not true. That is, the presence of stress does not imply length. This may be seen from the pair of examples in (19). Both forms have the same

number of syllables and the same stress pattern; the length in the second form is underlyingly present in the ANTIPASSIVE suffix.

(19) gáliŋáln^{y}u   *go-TRANSITIVIZER-PAST*
     gáliŋá:d^{y}iŋ   *go-TRANSITIVIZER-ANTIPASSIVE-PRESENT*

The conclusion that length is not derived from stress is reinforced by the data in (20). Each word has exactly four syllables and is stressed on the second and fourth syllables, but notice that each word differs from the others with respect to the location of vowel length. The first word has length on only the second vowel; the second word has length on only the fourth vowel; and the third word has length on both the second and fourth vowels.

(20) wawá:lin^{y}ú   *see-GOING-PAST*
     mad^{y}índaŋá:l   *walk up-TRANSITIVIZER-PAST*
     d^{y}uŋgá:riŋá:l   *run-GOING-TRANSITIVIZER-PAST*

The inescapable conclusion, from the data in (19) and (20), is that some instances of vowel length have to be lexical. Therefore, it cannot be the case that all vowel length is derived from stress.

Thus, the only way that stress placement could be described 'independently' of the surface distribution of vowel length would be to include information about stress in many of the individual lexical entries (e.g., in all those words which lack underlying vowel length). But even this solution proves inadequate in light of the following facts. Yidin^y has a rule which lengthens the penultimate syllable only if the word contains an odd number of syllables; the effect of this rule may be observed by comparing the (a) and (b) forms in (21) and (22).

(21)	(a) gúdagá-gu	*dog-PURPOSIVE*	(b) gudá:ga	*dog-ABSOLUTIVE*
(22)	(a) galbí:n-gu	*son-PURPOSIVE*	(b) gálbin	*son-ABSOLUTIVE*

Notice that the length contrast in (21) and (22) cannot be attributed to morphology, for the absolutive form has vowel length in (21) but not in (22), while the purposive form has vowel length in (22) but not in (21). Furthermore, Dixon points out that his word list contains 1200 nominals with trisyllabic citation (i.e., absolutive) forms, and in each such form the middle vowel is long, as in (21). He attributes the length in each of these forms to Penultimate Lengthening.[10]

This ability of Penultimate Lengthening to distinguish between odd- and even-numbered syllables in words of arbitrary length leads to an interesting problem: The only device in generative phonology that possesses such 'counting power' is iterative foot-building. Therefore, it must be the case that the grammar of Yidin^y builds bounded feet iteratively from left to right *before* Penultimate Lengthening applies.[11] Now, if these feet have heads, as Hayes' theory would claim, then they have to be left-headed; this is because all words which lack vowel length have stress on odd-numbered syllables (see 18). But this predicts derivations such as the following:

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[10]The precise formalization of Penultimate Lengthening is irrelevant to the present discussion.

[11]If feet were built in the opposite direction, i.e., from right to left, then the contrast between words with an odd number of syllables and words with an even number of syllables would show up at the left edge of the word. Consequently, the lengthening rule would have to apply near the beginning of the word instead of near the end.

(23) Input:	Foot-Building:	Lengthening:	Output:
	* * *	* * *	
* * * * *	(* *) (* *) (*)	(* *) (* *) (*)	
gudagudaga	guda guda ga	guda guda:ga	*gúdagúda:gá

The problem is that the output of (23) exhibits stress on the odd-numbered syllables instead of on the even-numbered ones. (The correct form is *gudágudá:ga)*.

The output of (23) might be 'patched up' with a rule that shifts all the stresses unless the representation already contains a stressed long vowel; this is the approach taken by Hayes 1982b. Notice, however, that this constitutes a return to Dixon's original generalization: Stress assignment is determined by the surface distribution of vowel length.

Thus, we have a paradox for Hayes' theory: Yidin^y stress assignment apparently has to precede Penultimate Lengthening, and yet the surface distribution of stress is determined entirely by the output of Penultimate Lengthening![12] In other words, the headedness of feet has to be indeterminate at the time of foot-building, for there is a rule (Penultimate Lengthening) which, even though it is crucial to determining the location of stress, cannot apply until *after* foot-building. Furthermore, regardless of the theory being applied, it is necessary for Penultimate Lengthening to intervene between the grouping of syllables into feet and the assignment of stress to particular syllables. Such intervention is not possible in a theory which combines foot-building

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[12]See Benger 1988 for a very similar set of phenomena in Cayuga.

and stress assignment into a single operation. This, then, constitutes an argument for building headless feet even in stress systems.

In summary, the assignment of stress in Yidin^y has to follow the rule of Penultimate Lengthening, which in turn has to follow the iterative construction of disyllabic feet. Since this order is required regardless of the theoretical framework that is used, it must be the case that Yidin^y feet are constructed without heads.[13] Thus, the Yidin^y data provide an argument for the existence of headless feet even in stress systems.

2.1.3. Summary.

Thus far, I have argued that heads are not needed in metrical theory. Rather, feet are inherently headless, and all the work that is done by heads in other theories is better accomplished by the concrete feature(s) of stress. Furthermore, I have shown that stress and metrical structure are formally independent of one another. The arguments for this point have focused on two claims. First, stress can exist apart from metrical structure and, second, metrical structure (even in stress systems such as that of Yidin^y) can exist apart from stress. The first claim was supported by the existence of lexical accent in certain languages as well as by the existence of unbounded stress. An additional argument for the existence of footless stresses is presented in section 5.2.

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[13]Alternatively, all heads can move rightward under certain conditions. Chapter 4 argues against this type of solution.

The second claim, i.e., that feet can exist apart from stress, was supported by two points. First, it is a well-established observation that morphological rules and processes never refer to the heads (stresses) of feet (Hammond 1989a, McCarthy and Prince 1990, Crowhurst 1991b). Second, feet have to be built before stresses can be assigned to them in Yidin^y. Since the rule of Penultimate Lengthening intervenes between foot-building and stress assignment, Yidin^y constitutes a clear example of a language in which stressed feet are initially stressless.

Thus, it has been shown that metrical structure and stress are formally independent of one another. However, this does not necessarily prove that stress is autosegmental. It remains to be shown that all of the properties of stress are consistent with all of the general properties of autosegments, and vice versa. This is the topic of the next section.

2.2. The Autosegmental Nature of Stress.

Recall that the purpose of this chapter is to demonstrate that (i) all feet are inherently headless and (ii) whenever stress is assigned to a foot, it is assigned via the principles of autosegmental theory. The first section began by defining the difference between metrical heads and stress and then arguing that the concept of a metrical head lacks empirical motivation. Accordingly, it was concluded that all feet are inherently headless. Regarding the claim that stress is autosegmental, it was pointed out that three points needed to be demonstrated: (i) stress can exist apart from feet; (ii) feet can exist

apart from stress; and (iii) the behavior of stress is consistent with the behavior of autosegments, and vice versa. The preceding section argued for (i) on the basis of the facts of exceptional stress in Macedonian. Arguments for (ii) were based on M&P's theory of prosodic morphology as well as the facts of stress and vowel length in Yidin^y (Dixon 1977, Crowhurst 1991a, Crowhurst and Hewitt, to appear). The question to be addressed now is this: Given the properties of stress and given the fact that stress and feet are able to operate independently of each other, what principles govern the behavior of stress? This section argues that stress is constrained by the principles of autosegmental theory. That is, stress is an autosegment.

I begin by reviewing the properties that have been attributed to stress, weeding out those alleged properties which may be shown to be independent of stress itself. I then review autosegmental theory, which was first proposed in Goldsmith 1976. The properties of autosegments are laid out, and the resulting list is then compared to the previously-complied list of the properties of stress. It is concluded that the formal behavior of stress is consistent with the claim that stress is an autosegment.

2.2.1. The Properties of Stress.

The purpose of this section is to compile a list of all those properties which may genuinely be attributed to stress based on what others have already observed. It will later be shown that this list is

nearly identical to the list of properties that are common to all autosegments.

Perhaps the most obvious property of stress is that it is normally realized as some kind of phonetic prominence such as length in English (Lehiste 1970) or tone in Creek (Haas 1977). Intensity (or volume) is sometimes claimed to be a feature of stress as well. See Fry 1955, 1958 for a discussion of intensity as a feature of English stress.

Notice, however, that there is no single phonetic feature which is common to all instances of stress, nor is there a single phonetic feature which is found only in stress. For example, in many languages (such as the modern Chinese dialects) tone plays a role which is generally viewed as different from that of stress. I attribute this view to the fact that the grammars of these languages exhibit no relationship between tone and metrical structure. Furthermore, in these languages tone can have more than one underlying value; this is not observed in languages in which stress is realized as tone. Thus, although stress in some languages is realized as tone, not all instances of tone can be classified as stress.

Likewise, although stress is realized as length in some languages (e.g., Hixkaryana; see section 1.2.2), lengthening processes can be triggered by other features besides stress. For example, Inkelas and Zec 1988 report that Serbo-Croatian has high tones, both underlying and derived, whose behavior exhibits no evidence of metrical structure. Nevertheless, there is a rule which lengthens the leftmost high-toned vowel in a word. Although this lengthening process has traditionally

been referred to as stress, it is in fact triggered only by the presence of a high tone. Whereas stress is normally assigned only to the edge of a foot or the edge of a word, in this case the target of lengthening is a high tone-bearing unit rather than a domain edge. Thus, Serbo-Croatian's lengthening rule is fundamentally different from instances in which foot-based stress is realized as length.

A significant conclusion about stress may be deduced from the above discussion. Although length and tone seem to be the most common phonetic correlates of stress, it is not the case that lengthening rules and tone assignment rules are always associated with what is commonly known as stress. I conclude, therefore, that phonetic features cannot be used as a sole diagnostic for identifying stress.

In addition to lengthening processes, stress has been claimed to play a role in shortening processes. The best-known example is English Trisyllabic Shortening *(divi:ne/divínity;* also known as Trisyllabic Laxing), but it has also been claimed that stress participates in a shortening rule in Fiji (Hayes 1991). However, the environment for shortening in each instance depends on other factors in addition to stress. In English, the target of shortening has to be in a closed syllable as well as stressed; in Fiji, the target of shortening has to be the stressed member of a word-final foot.[14] In either case, given the preceding section's conclusion that metrical structure and stress are formally independent of one another, it remains to be determined whether the trigger

[14]For a description of Trisyllabic Shortening in English, see Myers 1985, Halle and Vergnaud 1987b and Hammond 1990b. For the facts of Fijian shortening, see Hayes 1991, pages 126-32.

for shortening is stress or foot structure. Myers 1985 and Hammond 1990b both argue for the English case that the shortening process must be broken down into a sequence of two independent rules, resyllabification and shortening. They argue further that stress (or perhaps foot structure, as was just mentioned) triggers the resyllabification but not the shortening rule. I will not pursue these issues here, but it is apparent that the role of stress in shortening processes, if indeed it has a role at all, is yet to be determined. Because this involves issues which are beyond the scope of this study, I leave it as a topic for future research. In the meantime, I assume that all shortening processes may be reduced to rules involving only prosodic factors. Since the preceding section demonstrated that stress must be treated as formally separate from prosodic structure, I do not include the ability to participate in shortening processes in the list of the properties of stress.

One apparently legitimate property of stress is that it can be attracted to heavy syllables. This phenomenon, which was introduced in section 2.1.1 to account for the stress pattern of Huasteco, is further discussed and illustrated in sections 2.3.3.2 and 3.2.

Still another property of stress is that it is capable of moving independently of stress-bearing units. For example, Nespor and Vogel 1979 describe a process in standard Italian which moves the leftmost of two stresses leftward when they occur on adjacent syllables as the result of concatenation within a tightly-defined syntactic context. This is illustrated in (24).

(24) metá + tórta —> méta tórta *half cake*

Notice that stress is normally final in *metá*, as attested in (25). In this case, no movement of stress is observed because the second word is stressed on the second syllable, so concatenation does not create a clash.

(25) metá + canzóne —> metá canzóne *half song*

Data such as (24) and (25) provide evidence for the claim that stress can move in order to avoid a clash. This is consistent with the claim that universal filters such as the OCP do not block morphological or syntactic concatenation (Hewitt and Prince 1989; Myers 1991a). Rather, they trigger repair strategies such as the movement that is observed in the above Italian data. Examples of similar repair strategies in purely tonal systems are discussed in section 2.2.3.

There are also languages in which stress clash is resolved not by moving the clashing stress over one syllable but rather by demoting it to a subsidiary stress and simultaneously promoting some other subsidiary stress to a higher level. Perhaps the best-known example of this is the English Rhythm Rule (Chomsky and Halle 1968, Liberman and Prince 1977, Kiparsky 1979, Prince 1983, Hayes 1984, Halle and Vergnaud 1987b, Hammond 1988a). This process moves the leftmost of two primary stresses leftward when they occur on adjacent syllables in certain phrase-level contexts, as illustrated below.

(26)	(a)	Tènnessée	(b)	Ténnessèe Wílliams
(27)	(a)	Mìssissíppi	(b)	Míssissìppi Ríver
(28)	(a)	àpalàchicóla	(b)	ápalàchicòla árnie

Data such as (26) through (28) provide further evidence for the claim that metrical heads can move. However, the movement in this case is not to a formerly stressless position, as is the case in Italian, but rather to a position which already bore non-primary stress. Furthermore, the position from which primary stress moves does not remain stressless. Rather, it acquires a non-primary stress. Thus, the Rhythm Rule has the effect of 'swapping' the positions of a primary and a non-primary stress in order to resolve a clash between two primary stresses within a phrase. Since this study is concerned only with the derivation of primary stress and not with the derivation of distinctive degrees of stress, I defer the discussion of possible analyses of the English Rhythm Rule until chapter 6.

A different kind of stress shift occurs in Bedouin Hijazi Arabic. In this case, stress is observed to move to another vowel when its host vowel is deleted. The following facts are cited from Al-Mozainy, Bley-Vroman and McCarthy 1985 and based on Al-Mozainy 1981. First, the distribution of stress is described in (29).

(29) <u>Stress in Bedouin Hijazi Arabic</u> (Al-Mozainy 1981):

- (a) Stress is on the last syllable if it is superheavy (CVVC or CVCC).
- (b) Otherwise, stress is on the penult if it is heavy (CVV or CVC).
- (c) Otherwise, stress is on the antepenult.

Each of the three cases described in (29) is illustrated in (30): The final syllable is superheavy in (a) but not in (b) or (c), which correspond to (29)(b) and (c), respectively.

(30) (a)	maktúub	*written*	ḍaṛábt	*I hit*
(b)	maktúufah	*tied (f.sg.)*	gaabílna	*meet us (m. sg.)*
(c)	máalana	*our property*	yášrɨbin	*they (f.) drink*

Now, Bedouin Hijazi Arabic has a rule deleting short *a* in an open syllable if the following syllable is also open and contains short *a*. Al-Mozainy, Bley-Vroman and McCarthy 1985 formulate the rule as follows:

(31) <u>Low Vowel Deletion</u>: $a \rightarrow \phi$ / C ___ $[\text{Ca}]_\sigma$

This rule is responsible for the following alternations:

(32) (a)	sáḥab	*he pulled*	sḥábat	*she pulled*
	saḥábna	*we pulled*	sḥábaw	*they (m.) pulled*
			sḥában	*they (f.) pulled*
(b)	náxal	*palm trees*	nxálah	*a palm tree*
	g^yálaʕ	*castles*	g^yláʕah	*a castle*
	sálag	*hunting dogs*	slígah	*a hunting dog*[15]
(c)	γánam	*sheep*	γními	*my sheep*

What makes this particular grammar interesting, in terms of the claim that stress is autosegmental, is that Low Vowel Deletion is ordered *after* stress assignment. Although this order cannot be determined from the above data, it can be determined from the forms in (33).

(33) ʔínkisaṛ	*he got broken*	ʔinksáṛat	*she got broken*
ʔíntiḍaṛ	*he waited*	ʔintḍáṛan	*they (f.) waited*
ʔíftikaṛ	*he remembered*	ʔiftkáṛaw	*they (m.) remembered*
ʔíxtibaṛ	*he took an exam*	ʔixtbáṛaw	*they (m.) took an exam*

In each of the left-hand forms in (33), the penultimate syllable has underlying *a*, which is raised in an open syllable (depending on the

[15] The raising of *a* to *i* in this and the following example is the result of a separate process discussed in Al-Mozainy 1981.

adjacent consonantism) by an independent rule. Thus, the underlying representations are */ʔinkasaṛ/* and so on, with Low Vowel Deletion applying in the forms on the right. Al-Mozainy, Bley-Vroman and McCarthy point out that, although the left-hand forms are stressed in accordance with (29), those on the right are, at least on the surface, in violation of it. If Low Vowel Deletion were assumed to precede stress assignment, then forms such as **ʔínksaṛat*, with regular antepenultimate stress, would be expected. Since this is not observed, it must be the case that stress assignment precedes Low Vowel Deletion. However, now there is no means of explaining the location of stress in each of the right-hand forms except by assuming that the stress on the deleted vowel shifted to the following vowel rather than deleting with its original host vowel.

Other languages in which stress perseveres following the deletion of stressed vowels include Tiberian Hebrew (Prince 1975), Negev Bedouin Arabic (Kenstowicz 1983, Hayes 1991) and Unami (Goddard 1979, Hayes 1991). Hayes 1991 notes that this behavior of stress exactly parallels the tonal stability effects which gave rise, in part, to autosegmental theory. I return to this point in section 2.2.2.

To summarize thus far, four basic properties of stress have been identified. These include the following: (i) stress can be realized phonetically as tone, length and/or intensity; (ii) stress can be attracted to heavy syllables (Huasteco); (iii) stress can exhibit movement triggered by clash from an adjacent stress (Italian); and (iv) stress can exhibit stability under vowel deletion (Bedouin Hijazi

Arabic). I turn now to what might at first glance appear to be a property of stress but which in fact is not a property of stress at all.

In attempting to define the nature of stress, it has often been observed that in a number of languages stress tends to occur in an alternating pattern with non-stress. However, one must ask whether such alternating patterns are derived from some property of stress or whether they are derived from some property of metrical structure, or even whether they might be derived from something else. For example, notice that if feet are always binary, as is claimed in Hayes 1991 and McCarthy and Prince 1990, then the alternating pattern of stress and non-stress could be accounted for if there were some independent argument for limiting the number of stresses in a foot to one. The alternating pattern would then be attributed to that principle or set of principles governing the interaction of stress and metrical structure rather than to some property of stress.

The above line of reasoning is admittedly speculative, but other explanations are conceivable as well. For example, by appealing to the OCP as defined in section 1.2.4, it is possible, in principle, to derive alternating patterns without appealing to metrical structure. In particular, if multiple identical autosegments were inserted and immediately linked into a single large domain such as a long word, they would have to link to every other potential docking point (if they linked at all) in order to avoid violating the OCP.

Thus, the ability to occur in alternating patterns is not necessarily unique to stress, nor is there any clear evidence for at-

tributing the existence of such patterns in metrical systems to some property of stress. I assume, therefore, that the alternating patterns observed in stress systems may be attributed to other factors rather than to the intrinsic nature of stress.

To conclude the above discussion, only four genuine properties of stress have been identified thus far. These are listed in (34).

(34) Properties of Stress:

(a) Phonetic features of length, tone and/or intensity.
(b) Can be attracted to heavy syllables (Huasteco).
(c) Can undergo movement in a clash environment (Italian).
(d) Stability under vowel deletion (Bedouin Hijazi Arabic).

Having thus determined some of the properties of stress, the next section examines the properties of autosegments in order to provide a basis for evaluating the claim that stress is an autosegment.

2.2.2. The Properties of Autosegments.

Goldsmith 1976 points out that, in many languages, tones function as if their existence were independent of the segments on which they are phonetically realized. For example, in Etsako (Elimelech 1976) a word-final vowel is regularly deleted preceding another vowel, and yet its underlying tone remains, surfacing on the remaining vowel.[16] In order to explain this type of phenomenon, Goldsmith 1976 claims that tones exist on a plane that is separate from that of other segmental information in underlying representation. At any given point during a derivation,

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[16]The Etsako data are presented and discussed below.

these tones may either be associated to some tone-bearing unit (henceforth, *tbu;* usually a vowel), or else they may be unassociated; an instance of the latter is commonly referred to as a *floating tone*.[17] This is illustrated in (35), where T_1, T_2 and T_3 represent three tones located on the autosegmental plane and V_1 and V_2 represent two tbus located on the segmental plane. The line between T_1 and V_1 indicates an association between these two entities, as does the line between T_2 and V_2. Notice that T_3 is floating, i.e., it is not associated to a tbu.[18]

(35) <u>Autosegmental Plane</u>: $\begin{matrix} T_1 & T_2 & T_3 \\ | & | & \\ V_1 & V_2 & \end{matrix}$

<u>Segmental Plane</u>:

The original idea behind autosegmental theory, then, is that tonal features can function independently of all other features. However, since tonal features always surface together with segmental features, there has to be some means of linking the elements of the autosegmental plane to elements in the segmental plane. Building upon the work of Williams 1976, Goldsmith 1976, Clements and Ford 1979 and Halle and Vergnaud 1982, Pulleyblank 1986 proposes to handle this using the principles stated in (36), known as the *Association Conventions*.

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[17]Peng 1992 argues that tones universally associate to moras rather than directly to vowel segments. This distinction is not relevant to the present discussion.

[18]Autosegmental theory has been applied to similar behavior involving non-tonal features such as [NASAL] (Goldsmith 1976, Safir 1982) and [ADVANCED TONGUE ROOT] (Clements 1981, Archangeli and Pulleyblank 1989). See further discussion below.

(36) Association Conventions (Pulleyblank 1986):

(i) Autosegmental tones are mapped onto a sequence of tone-bearing units from left to right and in a one-to-one relation; and

(ii) Association lines do not cross.

The basic idea behind (36) is that the association of tonal autosegments to segments must be accomplished in a strictly local fashion. That is, the linear order must be preserved on the autosegmental plane just as it is on the segmental plane. This is illustrated in (37), where the first tone associates to the first tbu and the second tone associates to the second tbu.

(37)
$$\begin{array}{llcl} \underline{\text{Autosegmental Plane}}: & T_1\ T_2 & & T_1\ \ T_2 \\ & & \longrightarrow & \,|\quad\ | \\ \underline{\text{Segmental Plane}}: & V_1\ V_2 & & V_1\ \ V_2 \end{array}$$

If the Association Conventions are correct, then (37) illustrates the only possible way in which two autosegments (T_1 and T_2) could associate to a sequence of two tbus (V_1 and V_2); (38a) and (b) are *not* possible association schemes because the association is not one-to-one in (38a), and the association lines cross in (38b).[19]

(38)
$$\begin{array}{llll} \text{(a)} & {*T_1\ \ T_2} & \text{(b)} & {*T_1\ \ T_2} \\ & \ \ |\ \ / & & \quad\ \ \mathrm{X} \\ & \ \ V_1\ \ V_2 & & \ \ V_1\ \ V_2 \end{array}$$

The Association Conventions are able to explain the following common asymmetry that cannot be accounted for in a purely segmental approach to phonology. For many languages, it has been noted that there

[19] Actually, the Association Conventions are not universal; this is discussed below.

is a gap in the surface distribution of tone in polysyllabic words. For example, Mende (Leben 1973, 1978) has only two underlying tones: HIGH (H) and LOW (L). Considering only those words which contain three syllables or less, the Association Conventions predict that there are eight logically possible surface combinations of H and L; these are listed with examples in (39). The majority of monomorphemic words have one of the first five tonal patterns listed in (39); parentheses indicate how each tonal pattern surfaces in longer words. Notice that the final three combinations are completely unattested.[20]

(39) Mende Tone Distribution in Monomorphemic Words (Leben 1978):

	One Syllable:		Two syllables:		Three syllables:	
H(HH):	kɔ́	*war*	pɛ́lɛ́	*house*	háwámá	*waistline*
L(LL):	kpà	*debt*	bɛ̀lɛ̀	*trousers*	kpàkàlì	*tripod chair*
HL(L):	mbû	*owl*	ngílà	*dog*	félàmà	*junction*
LH(H):	mbǎ	*rice*	fàndé	*cotton*	ndàvúlá	*sling*
LHL:	mbâ	*companion*	nyàhâ	*woman*	nìkílì	*groundnut*
*HLH						
*HHL						
*LLH						

The absence of instances of the last three patterns in (39) cannot be explained under a segmental approach to tone. This is because the latter assumes that each underlying tone is associated to some segment in underlying representation; the patterns HLL and LHH are interpreted as sequences of three tones, so there is nothing to preclude the exis-

[20]Following Leben 1978, the following typographic conventions are used in the Mende data: An acute accent represents H, as in *kɔ́*; a grave accent represents L, as in *kpà*. A sequence of two or more accentual diacritics over a single vowel represents a tonal contour. For example, *mbǎ* has the tonal pattern LH and *mbâ* has the pattern LHL.

tence of the unattested patterns *HHL and *LLH.[21] In contrast, the autosegmental approach, coupled with the OCP, offers a very simple explanation for the absence of the patterns *HHL and *LLH. Recall from section 1.2.4 that the OCP prohibits the occurrence of adjacent identical features within a single domain. In terms of tonal phenomena, this excludes the possibility of a word having two identical tones adjacent to one another on the autosegmental tone tier. Consequently, the sequences [HH] and [LL] are prohibited, so each of these surface patterns, whenever it occurs, has to be interpreted as a single tone linked to two tbus. This is illustrated in (40), where V_1 and V_2 are tbus and T is a tone.

(40)
$$\begin{array}{ccc} & T & \\ / & & \backslash \\ V_1 & & V_2 \end{array}$$

The linking of a single autosegment to more than one docking point as in (40) is generally referred to as *one-to-many mapping*.

Viewing the final two patterns in (39) in light of the OCP, a significant generalization emerges: Whenever a word has two underlying tones, the first one links only to the first vowel. That is, the representation in (41a) is allowed, but the representation in (b) is *not* allowed.

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[21]The absence of one pattern, *HLH, remains to be explained, but a discussion of this problem is beyond the scope of the present work. The point made here is that an autosegmental approach to tone provides a simple, natural explanation for (most of) the observed gaps in the distribution of tone in Mende. In contrast, a segmental approach to tone is incapable of accounting for any of these gaps.

(41) (a) $\begin{array}{lll} T_1 & T_2 & \\ | & | \backslash & \\ V_1 & V_2 & V_3 \end{array}$ (b) * $\begin{array}{lll} T_1 & & T_2 \\ | \backslash & & | \\ V_1 & V_2 & V_3 \end{array}$

Notice that this is exactly what is predicted by the Association Conventions: Tones must map onto a sequence of tbus from left to right and in a one-to-one relation. The configuration in (b) is thus prevented from occurring, and the spreading in (a) is readily explained by Mende's language-particular requirement that every vowel be linked to a tone.

The occurrence of two or more distinct tones on a single autosegmental plane, as in some of the examples in (39), is generally known as a *melody*. The ability to form melodies is another feature of autosegments.

Thus, Goldsmith's autosegmental theory provides a simple, natural explanation for the major gaps in the distribution of Mende tone. In contrast, a segmental approach to tone is incapable of accounting for these gaps.

However, there is a problem with the first part of the Association Conventions in that the direction of autosegmental association does not appear to be universal. For example, Hollenbach 1988 argues that tonal association in Copala Trique (an Otomanguean language of Mexico) has to be from right to left rather than from left to right. Nevertheless, the remaining aspects of the Association Conventions appear to be universal, i.e., autosegments associate directionally (either left-to-right or right-to-left) in a one-to-one relation, and association lines may not cross.

Following Archangeli and Pulleyblank (in press), I henceforth use the term *linking* in place of *association*, and I assume that individual grammars are free to specify the direction of linking (left-to-right or right-to-left).[22] I further assume, following Pulleyblank 1986 and Yip 1988b, that spreading is only by rule and does not occur until after all the available autosegments have linked.[23]

Given that an autosegment may be floating at one stage of a derivation and be linked at some later stage, as illustrated in (37), it is possible for other phonological and morphological processes to occur prior to linking. Consequently, a floating autosegment which is part of a morpheme's underlying representation might end up linking to a p-bearing unit that is *not* part of that morpheme.[24] For example, in San Miguel El Grande Mixtecan, certain words have a floating H-tone which links to the first vowel of the ensuing word. The following account is

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[22]Archangeli and Pulleyblank (in press) argue that linking is always by rule rather than automatic. A major basis for this claim is the observation that linking can occur in either direction. However, while the latter suggests that the linking process is parameterized, it does not entail that linking has to be a rule. For arguments concerning the question of conventions versus rules see Goldsmith 1976, Williams 1976, Halle and Vergnaud 1982 and Pulleyblank 1986 as well as Archangeli and Pulleyblank (in press). Since this issue is not crucial to my theory, I leave it as an open question.

[23]Like linking, spreading may occur in either direction. For example, Archangeli and Pulleyblank (in press) argue that the feature [-ADVANCED TONGUE ROOT] spreads from left to right in Wolof and from right to left in Yoruba.

[24]Henceforth, I utilize Pulleyblank's 1986 term *p-bearing units* (the class of slots to which some arbitrary autosegment is linked) in place of *tone-bearing units* (the class of slots to which tones are linked) in order to emphasize that I am talking about the behavior of autosegments in general, and not just the behavior of tone.

from Goldsmith 1990, which is based on Pike's 1948 description of the data.

The underlying form for 'eat' in (42a) differs from that of 'go away' in (43a) only in that the former contains a floating H-tone whereas the latter does not.[25] This difference shows up when these words are followed by the word *suči* 'child', which exhibits the tonal pattern LH in isolation. In (42b), the tonal pattern of *suči* is HH, whereas in (43b) it has the normal pattern LH.

```
(42) (a)  M H                   (b)  M H L H
          |                          |  \ǂ |
         ke:     eat                ke: suči     the child will eat

(43) (a)  M                     (b)  M   L H
          |                          |   | |
         ke:     go away            ke: suči     the child will go away
```

This difference is attributed to the fact that the word for 'eat' has a floating H-tone on its right edge. In contrast, the word for 'go away' has no floating tone.

Thus, the data from San Miguel El Grande Mixtecan instantiate the existence of words containing a tone which shows up only on neighboring words and never on the word with which the tone is underlyingly associated. Similar mismatches between tones and morphemes have been documented in Supyire (Carlson 1985, Goldsmith 1990) and the Bantu languages

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[25]It is not clear from the sources just which tonal features should be represented underlyingly, but this question is beyond the scope of the present study. The point here is that the underlying representations for 'eat' and 'go away' differ only in that the former contains a floating H-tone while the latter does not.

Tiv and Bamileke-Dschang (Pulleyblank 1986), to name just a few examples.

It is also possible for an entire morpheme to consist of nothing more than a floating tone. In order to surface, this morpheme must first combine with a morpheme that contains a segment to which the floating tone can link. This is illustrated in (44), where (T) in this case is a morpheme consisting only of a floating tone.

(44) $\text{(T)} + \text{[STEM]} \longrightarrow \begin{array}{c} \text{T} \\ | \\ \text{[STEM]} \end{array}$

Tiv is an example of a language with this kind of floating tone. The following account is taken from Pulleyblank 1986. In Tiv, all verb stems can be characterized as conforming to one or the other of the following two patterns:

(45) (a) <u>H-stem verbs</u> (b) <u>L-stem verbs</u>

$$\begin{bmatrix} \text{V} & \text{(V)} & \text{(V)} \\ \text{H} & & \end{bmatrix} \qquad \begin{bmatrix} \text{V} & \text{(V)} & \text{(V)} \\ \text{L} & & \end{bmatrix}$$

Pulleyblank demonstrates that a L-tone -- whether linked or floating -- has a downstepping effect on a following H-tone. He then notes that the General Past creates an initial downstep (indicated by $^!$) when added to a H-stem and has no visible effect on a L-stem, as illustrated in

(46).[26] Therefore, Pulleyblank characterizes the General Past morpheme as a prefix consisting of nothing more than a floating L-tone.

(46) <u>Tiv General Past</u> (Pulleyblank 1986:82):

1 syllable:	ꜝvá *came*	ꜝH	dzà *went*	L
2 syllables:	ꜝúngwà *heard*	ꜝHL	vèndè *refused*	LL
3 syllables:	ꜝyévèsè *fled*	ꜝHLL	ngòhòrò *accepted*	LLL

Under Pulleyblank's account, the occurrence of downstep in (46) is consistent with the observed behavior of LH sequences in Tiv. Apart from autosegmental theory, there is no principled way to account for these facts.[27]

Another advantage of autosegmental theory over all strictly segmental approaches to tone assignment was alluded to earlier. In many languages, a tone remains in the representation following the deletion of the vowel that it was linked to. For example, in Etsako there is a rule deleting a word-final vowel that is followed by another vowel; the effects of this rule may be observed in (47).[28]

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[26]Pulleyblank attributes non-initial L-tones in words such as *ꜝyévèsè* to a default rule which assigns L to any toneless vowel. The phenomenon of downstep is discussed further below.

[27]See Hollenbach 1988 for a similar instance of morphemic tone in Copala Trique.

[28]The formalization of this rule raises issues which are beyond the scope of this study. Since the form of the rule itself is irrelevant to the discussion of tonal stability, I do not attempt to formalize it.

(47) <u>Etsako</u> (Elimelech 1976, Leben 1978):

ówà	*house*	+	ówà	*house*	—>	ówǒwà	*every house*
ídù	*lion*	+	ídù	*lion*	—>	ídwǐdù	*every lion*

In each of the examples in (47), the deleted vowel's tone relinks to the next vowel instead of simply deleting. As Leben 1978 points out, it would be quite difficult for a segmental theory of tone to explain why tone should exhibit such stability. In contrast, autosegmental theory provides a ready explanation: If Etsako tones are assumed to be floating autosegments, as was already demonstrated to be true of Mende tones, then the observed tonal stability is accounted for simply by ordering the vowel deletion rule before tonal linking.

Another phenomenon that autosegmental theory is able to account for is *tonal polarity*. For example, Pulleyblank 1986 cites the following Margi data from Hoffman 1963. The underlying representation of each Margi verb may contain either a single L-tone or a single H-tone, or it may contain no underlying tone. The surface tone of the present tense prefix *[a-]* is determined entirely by the underlying tone of the verb stem to which it attaches. The interesting aspect of these tonal alternations is that the surface tone of the present tense prefix is always the opposite of the underlying tone of the stem. For example, the prefix gets L if the stem has H, but if the stem has L then the prefix gets H. This is illustrated below.

(48) <u>Margi Present Tense</u> (Pulleyblank 1986:205-207):

(a) <u>Underlying L</u>:	wì	*to run*	áwì yú	*I run*
(b) <u>Underlying H</u>:	sá	*to err*	àsá yú	*I err*
(c) <u>No Underlying Tone</u>:	sà	*to drink*	àsá	*drink (PRES)*

Pulleyblank discusses various non-autosegmental approaches that have been taken in analyzing data such as these, pointing out in each case that the analysis runs into theoretical complications with respect to underspecification theory. As an alternative, Pulleyblank accounts for the alternations in the surface tone of the present tense prefix by assuming that it has the following underlying representation, where *a* denotes the appropriate segmental vowel features, *[+ex]* denotes extratonality and *H* denotes high tone:

(49)
$$\begin{bmatrix} \text{a} \\ [+\text{ex}] \\ \text{H} \end{bmatrix}$$

The verbs in (48) appear as follows after present tense prefixation:

(50)

(a)
$$\left[\begin{matrix} \text{a} \\ [+\text{ex}] \\ \text{H} \end{matrix} \begin{bmatrix} \text{wi} \\ | \\ \text{L} \end{bmatrix}\right]$$

(b)
$$\left[\begin{matrix} \text{a} \\ [+\text{ex}] \\ \text{H} \end{matrix} \begin{bmatrix} \text{sa} \\ | \\ \text{H} \end{bmatrix}\right]$$

(c)
$$\left[\begin{matrix} \text{a} \\ [+\text{ex}] \\ \text{H} \end{matrix} \begin{bmatrix} \text{sa} \\ \\ \\ \end{bmatrix}\right]$$

The correct surface forms are derived from these underlying representations as follows: First, a rule deletes a floating H when adjacent to another H. This rule will not affect the representation in (50a) or (c) but will delete the prefixal H in (50b):

(51)

(b)
$$\left[\begin{matrix} \text{a} \\ [+\text{ex}] \\ \text{Ø} \end{matrix} \begin{bmatrix} \text{sa} \\ | \\ \text{H} \end{bmatrix}\right]$$

Next, the floating H in (50c) will link to the only available docking point, which is the underlyingly toneless stem vowel:

(52) (c)

```
┌        ┌    ┐ ┐
   a     │sa  │ │
 [+ex]   │/   │ │
        H│    │ │
└        └    ┘ ┘
```

Finally, Pulleyblank assumes that extratonality is lost (by a universal convention; see Kiparsky 1985) at the phonetic level. This results in the following representations:

(53) (a) (b) (c)

```
┌     ┌    ┐ ┐   ┌     ┌    ┐ ┐   ┌     ┌    ┐ ┐
  a     wi          a     sa          a     sa
        |                 |                 |
  H     L                 H                 H
└     └    ┘ ┘   └     └    ┘ ┘   └     └    ┘ ┘
```

As the final step, the floating prefixal H will associate to the free vowel [a] in (53a), while this same vowel in (b) and (c) will be assigned a L by default.

Pulleyblank points out that, unlike previous analyses of tonal polarity, the foregoing autosegmental analysis requires no morphologically-conditioned rules, nor does it utilize anything other than commonly-occurring rules and representations. This, then, constitutes an argument in favor of autosegmental theory.

To summarize thus far, autosegmental theory is based upon the observation that, in some languages, tones function in phonological rules as though they were not linked to segments at all, even though they

clearly are linked to segments in surface representation. Four distinct benefits are obtained from applying autosegmental theory to the analysis of tone: First, the surface distribution of tone in languages such as Mende is readily accounted for. Second, autosegmental theory provides a simple, natural means of formally representing floating tone such as that found in San Miguel El Grande Mixtecan as well as tonal morphemes such as Tiv's General Past. Third, the effects of tonal stability in Etsako are readily accounted for. And, finally, autosegmental theory makes it possible to account for the tonal polarity effects in Margi using only commonly-occurring rules and representations. These benefits are unattainable under a purely segmental theory of tone.

Notice that the foregoing discussion attributes several formal properties to autosegments. First, they can 'float' on a plane by themselves, independently of the segmental units that they normally surface on. This property gives rise to the surface asymmetry in the distribution of tones in Mende as well as the stability effects of Etsako tone, the floating H-tone in San Miguel El Grande Mixtecan and the morphemic L-tone in Tiv. Second, autosegments can exhibit one-to-one mapping to segments as in Mende *ngílà, fàndé*. Third, they can exhibit many to one mapping (Etsako *ówó̱wà)* as well as one to many mapping resulting from spreading (Mende *háwámá)*. In addition, all of these properties are needed in order to account for tonal polarity in Margi.

The above discussion has utilized examples from the literature on tone to illustrate the formal properties of autosegments, but other kinds of features are capable of functioning as autosegments as well.

For example, Safir 1982 demonstrates that the feature [+NASAL] is autosegmental in Capanahua, and Archangeli and Pulleyblank 1989 attribute autosegmental behavior to the feature [-ATR] in Yoruba based upon its asymmetrical distribution.

It should also be noted that, even though tone, [NASAL] and [ATR] all share the ability to function as autosegments, there are some differences in their behavior. For example, downstep is a phenomenon which is observed only in tonal features; specifically, it is the lowering of a H-tone triggered by a preceding L-tone. Nothing comparable to downstep has ever been observed between other kinds of autosegments such as [ATR] or [NASAL]. Likewise, melodies (i.e., sequences of two or more non-identical autosegments on the same plane) are observed in many tonal systems (e.g., see the Mende data in 39), but some autosegments apparently never combine to form melodies. Examples of such autosegments include [ROUND] and [VOICE]. To my knowledge, no autosegmental sequence such as [+ROUND][-ROUND] or [-VOICE][+VOICE] has ever been reported.

To summarize the foregoing discussion, autosegments differ not only in terms of phonetic realization but also in terms of their distribution and/or phonological behavior. However, every autosegment shares the ability to 'float' independently of the segmental units that it normally surfaces on. This ability may be evidenced by a distributional asymmetry, by stability under deletion of a host segment, by the existence of a non-segmental morpheme, or by polarity effects.

Having thus established the basic properties of autosegments, the next step is to compare these properties with the list of the properties

of stress that was compiled in section 2.2.1. The conclusion, for which the next section argues, is that stress is an autosegment.

2.2.3. A Comparison of Stress and Autosegments.

The primary aim of this chapter, as stated in the introduction, is to demonstrate that (i) all feet are inherently headless and (ii) whenever stress is assigned to a foot, it is assigned via the principles of autosegmental theory. Section 2.1 discussed the distinction between the notions of *metrical head* and *stress* and argued that, since stress is the only diagnostic for the presence of a metrical head, the latter is redundant and should be eliminated from phonological theory. It was concluded, therefore, that feet are universally headless.

In order to prove the validity of the second claim, three distinct points must be established. First, stress can exist without any corresponding metrical structure; this was demonstrated in section 2.1.1 using the facts of exceptional stress in Macedonian. Second, feet can exist apart from stress; section 2.1.2 argued for this claim using the theory of prosodic morphology and the facts of Yidin^y stress. Finally, it must be shown that the observed behavior of stress is consistent with what is known about autosegments, and vice versa. Sections 2.2.1 and 2.2.2 reviewed the properties of stress and autosegments, respectively. All that remains is to show that these two sets of properties are identical in all crucial respects; this is the task of the present section.

Before proceeding, it should be emphasized that I am comparing only the formal behavior of stress and autosegments, not their phonetic

substance. I am not claiming that all features which are capable of autosegmental behavior should be observed in stress systems, nor am I claiming that all stress systems exhibit autosegmental behavior. For example, to my knowledge, no language has been found in which the primary feature of stress is [+NASAL] or [+ATR]. This fact is of no concern to this study, for the autosegmental theory of stress that I am proposing claims only that stress is an autosegment; it makes no claims about the phonetic substance of stress. I assume that this autosegment is unique to stress systems, but it is also conceivable that stress should be represented as nothing more than a conceptual place-holder for whatever autosegment a grammar selects to represent stress. Notice, however, that the claim that stress is autosegmental is distinct from the claim that stress is represented by a particular autosegment such as tone. The former is the primary claim of this thesis; the latter is left as a topic for future research. Furthermore, there are stress systems which do not exhibit autosegmental behavior, just as there are tonal systems which do not exhibit autosegmental behavior. In either case, grammars are free to vary in their selections of rules and underlying representations; the absence of autosegmental behavior of a feature in one language does not imply that it cannot exhibit autosegmental behavior in some other language.

The basic properties of stress and autosegments are summarized and compared in (54). In those instances where a feature has already been instantiated, the name of the relevant language(s) is listed under stress or autosegments, as appropriate. As it stands in (54), only one

of the ten features is instantiated for both stress and autosegments. This is stability, which was instantiated in Bedouin Hijazi Arabic (section 2.2.1) and Etsako (section 2.2.2) for stress and autosegments, respectively.

(54) <u>A Comparison of Stress and Autosegments</u>

	Stress	Autosegments
Stability:	BH Arabic	Estako
Floating:		Mende
Morphemic:		Tiv
Polarity:		Margi
One-to-one Mapping:		Mende
Many-to-one Mapping:		Etsako
Melodies:		Mende
One-to-many Mapping:		Mende
Attracted to heavy σ:	Huasteco	
Movement under Clash:	Italian	

Now, the hypothesis that stress is an autosegment implies that all of the gaps in (54) must be either filled or excluded for principled reasons. That is the task of the present section.

The first gap in (54) concerns the claim that stress should be able to 'float', just as was shown to be the case for tones in Mende. The next chapter presents data demonstrating that a number of Mayo words have a lexical accent (i.e., stress) that floats during part of the

derivation. This claim is further validated in chapter 5 for Mayo as well as for Tagalog.

The next gap in (54) concerns the prediction that stress may be morphemic. This is in fact a common phenomenon, as exemplified by the final stress in Spanish which corresponds to third person singular preterite (*háblo* 'I speak' / *habló* 'he spoke'). Under the autosegmental theory of stress proposed in the next section, the Spanish third person singular preterite may be viewed as an autosegmental stress (symbolized by *) which links by rule from right to left, as illustrated below.

```
(55)             *              *
                                |
     hablo +          —>    hablo       habló
```

In the above example, I assume that the morphemic stress is inserted and linked prior to the application of the regular rules of stress assignment. The OCP (as defined in section 1.2.4) will then prevent the assignment of regular stress. This is illustrated below, where regular penultimate stress in verbs is derived by building a disyllabic foot from right to left and then linking a stress autosegment from left to right to that foot.[29]

```
(56)                 1st Person Present:    3rd Person Preterite:

                                                    *
                                                    |
     Input:          hablo                  hablo
```

---

[29]For a full discussion of the facts of stress in Spanish, see Harris 1983.

```
Regular Stress:      *
                     |
                  (hablo)               Blocked by OCP

Output:           hablo                 habló
```

One might object to labeling the Spanish third person singular preterite as an example of a morphemic stress, claiming instead that it is a morpheme-specific rule. The distinction between these two types of phenomena is illustrated in the following comparison of Tiv and Yoruba, based on Pulleyblank 1986 and Archangeli and Pulleyblank (in press).[30] In Tiv, the Recent Past is derived by suffixing a high tone (H) to the verb stem. This H-tone associates to the leftmost toneless segment in the word, as illustrated below:[31]

(57) Tiv Recent Past:

```
T       +  H    —>    T H       * T   H
                      | |         |   |
V V V                 V V V       V V V
```

Notice that the representation in (57) allows for the possibility of two H-tones occurring adjacent to one another in apparent violation of the OCP. As Pulleyblank points out, however, the OCP is not violated if the Recent Past morpheme is on a tier that is separate from that of the stem; this is allowed under the Morphemic Plane Hypothesis (section

[30]The relevant facts from Tiv, which I represent only schematically, are found in Pulleyblank 1986:68-71. The Yoruba facts, which are likewise represented schematically, are found in Archangeli and Pulleyblank (in press).

[31]In this and subsequent diagrams, *V* indicates a vowel (or its mora), which is the tone-bearing unit in Tiv and Yoruba, *H* and *L* indicate high and low tones, respectively, and *T* indicates any tone.

1.2.4). Of course, the different morphemic planes have to merge prior to the output. Nevertheless, Pulleyblank argues that the presence of two distinct H's in the representation is independently required at an intermediate stage of the derivation, and the Morphemic Plane Hypothesis predicts that such a representation is possible.

Yoruba has an object postclitic which, like the Recent Past in Tiv, consists only of a H-tone. Unlike what was observed in Tiv, however, Yoruba's object postclitic links to the rightmost tbu, if possible (i.e., if no OCP violation would result). Otherwise, it does not link at all. This is illustrated below.

(58) <u>Yoruba Three-vowel stems</u>:

```
T      + H   —>    T   H     * T H
                   |   |       | |
V V V              V V V       V V V
```

(59) <u>Yoruba Two-vowel stems</u>:

```
(a) L      + H   —>    L H              (b)     + H —>      H
                       | |                                  |
    V V                V V                  V V           V V

(c) H      + H   —>    H         * H H    *  H      *   H
                       |           | |      / \         |
    V V                V V         V V     V   V      V V
```

On the basis of this difference in the linking behavior of the suffix-like H-tones in Tiv and Yoruba, Archangeli and Pulleyblank (in press) argue that the final H-tone in (58) and (59) is actually not a morpheme. Rather, they claim, it is inserted and linked from right to left (instead of the usual left to right direction) via a morphologically-

specified rule. The Morphemic Plane Hypothesis does not come into play in this case because H is inserted by a rule, not as part of a morphemic representation.

Thus, Archangeli and Pulleyblank (in press) argue for a distinction between a morphemic tone, such as Tiv's Recent Past, and a rule-based tone, such as Yoruba's object postclitic. If such a distinction is needed in order to account for tonal phenomena, then the same distinction should be relevant for stress since I am claiming that stress, like tone, is autosegmental. Accordingly, one might ask whether the above data from Spanish do not in fact represent rule-based stress rather than morphemic stress.

However, an alternative explanation is available for the contrast between the behavior of Tiv's Recent Past and the behavior of Yoruba's object postclitic. Following H&V's concept of cyclicity (section 1.2.3), the tone of Tiv's Recent Past suffix may be assumed to be on a different plane from that of the stem, just as in Pulleyblank's analysis. Again, this allows it to link to the leftmost toneless vowel without violating the OCP. In contrast, the tone of Yoruba's object postclitic enters the derivation postlexically and is consequently on the same plane that the stem is on. The OCP prohibits it from linking next to another H-tone, and the non-default right to left direction of linking may be accounted for by its syntactic position to the right of the stem.

The above analysis accounts for the contrast between the behavior of Tiv's Recent Past and the behavior of Yoruba's object postclitic

without resorting to a distinction between morphemic autosegments and rule-based autosegments. I conclude, therefore, that such a distinction is not required, so the aforementioned instance of morphemic stress in Spanish may be viewed as a legitimate counterpart to morphemic tone.

The next gap in (54) concerns the phenomenon of polarity. Section 5.3 demonstrates that Tagalog has a suffix which exhibits polarity effects parallel to those found in Margi (section 2.2.2) except for the fact that the relevant autosegment in Margi is a high tone whereas the corresponding autosegment in Tagalog is identified as a stress autosegment. I present an analysis which is parallel to Pulleyblank's analysis of Margi's polarizing prefix, concluding that the phenomenon of polarity is instantiated in the stress system of Tagalog.

Next, consider the property of one-to-one mapping, which was observed earlier with regard to the Mende tone data. In that case there were two lexical tones, H and L. In contrast, all stress systems have at most one kind of lexical stress, not two. One-to-one mapping is trivially attested in these systems because there is only one kind of stress autosegment, and the OCP prohibits the occurrence of adjacent identical autosegments within a single domain. However, the spreading of a single stress could conceivably result in the occurrence of stress on two adjacent stress-bearing units. This possibility is discussed in section 6.2.

Likewise, following McCarthy 1981, I assume that many-to-one mapping is found only in tonal systems because tone is the only multi-val-

ued autosegment.[32] The OCP prevents grammars from linking more than one token of a single-valued autosegment such as stress to a single p-bearing unit.

The next property in (54) is that of melodies, i.e., the occurrence of two or more distinct autosegments on the same plane. If stress is indeed an autosegment, as I claim, then the occurrence of two or more degrees of stress in the surface representation of a language may in some cases be interpreted as a stress melody. For example, primary stress in Malayalam is realized as a low tone on either the first or second syllable; all other stresses are realized as high tones on subsequent long vowels and on the final syllable (Mohanan 1982). Mohanan accounts for this distribution with a word melody of the form LH. He proposes that the first member of this melody anchors to the primary stress while the H links and spreads rightward to all other stresses. For examples and details of this analysis, see Mohanan 1982. The point to be noted here is simply that Malayalam stress exhibits a melody.

Other languages with more than one degree of stress (whose distinctions may be realized in terms of tone, length and/or volume) include English (Hayes 1981), Warao (Osborn 1966, section 3.1.1.1),

---

[32]McCarthy 1981 (page 383) argues that many-to-one mapping is normally prohibited in nontonal autosegmental systems. The reason he gives for this prohibition in Arabic's templatic morphology is to prevent the creation of segments with multiple specifications for point and manner of articulation features. McCarthy does not address apparent counterexamples such as affricates and prenasalized segments. However, these are not of direct consequence to my proposal because stress involves a basic contrast, across stress-bearing units, between prominence and nonprominence. It is not clear, therefore, how a single stress-bearing unit could exhibit a contour such as [+stress][-stress].

Waalubal (Crowley 1978, Hammond 1989b, section 3.2) and West Greenlandic Eskimo (Schultz-Lorentzen 1945, Hayes 1981, section 3.2), to name but a few. In each of these languages, the distinction between degrees of stress is derived rather than underlying. As far as I know, there is no language which exhibits an underlying contrast between two or more degrees of stress.[33] The explanation for this observation lies beyond the scope of this study; the only point to be made here is that stress melodies do occur even though they apparently are not attested in underlying representation. A mechanism for deriving multiple degrees of stress is suggested in section 6.1.

The next property that is missing from (54) is one-to-many mapping, i.e., the mapping of a single autosegment to more than one p-bearing unit. In this case, there is no principled reason why one-to-many mapping should not be able to apply in stress systems, and yet this seems to be unattested. That is, stress does not appear to spread throughout a foot (or any other domain). Rather, stress normally surfaces on only one member of a foot. If stress is in fact an autosegment, then why don't we observe instances of stress spreading throughout a foot? Section 6.1 suggests a possible explanation, but for now I leave this as an open question.

Two gaps in (54) remain to be addressed. These are attraction to heavy syllables and movement under clash. Each of these was noted earlier as a property of stress in certain languages, but neither has been

[33]However, Bickmore 1992 argues that Kinyambo exhibits multiple underlying degrees of stress.

observed to be a property of traditional autosegments. Possible explanations for each of these gaps in (54) are discussed below.

First, consider the attraction of stress to heavy syllables. As section 2.1.1 pointed out, this phenomenon is observed in a number of languages. To my knowledge, however, no one has ever claimed that this is a property of autosegments. How, then, is this to be explained in light of the claim that stress is an autosegment? I suggest that the attraction of stress to heavy syllables is simply an idiosyncratic property of stress.[34] This does not invalidate the claim that stress is autosegmental, for each autosegment has idiosyncratic properties. For example, section 2.2.2 pointed out that downstep is unique to tone. Furthermore, tone is attracted to stress in some languages such as Creek (Haas 1977, Halle and Vergnaud 1987b), Capanahua (Loos 1969, section 4.2), Hopi (Jeanne 1978, Hayes 1981), Malayalam (Mohanan 1982) and Kimatuumbi (Sietsema 1989), just as stress can be attracted to heavy syllables. I assume, therefore, that the attraction of stress to heavy syllables is an idiosyncratic property of stress. As such, it does not invalidate the claim that stress is an autosegment.

The final gap in (54) concerns the apparent absence of movement under clash in autosegmental systems. In fact, such behavior is logically possible for autosegments, but the formalism of autosegmental theory requires that it be handled via two distinct steps rather than

[34]ATR is another autosegment that can be attracted to heavy syllables. For example, in Wolof, [-ATR] is obligatory on low vowels if they are long, and in Menomini, [+ATR] spreads only to nonlow vowels, and only if they are long (Archangeli and Pulleyblank, in press).

one, as has been the case in most accounts of stress clash resolution. First, an autosegment delinks because of an OCP violation (see section 1.2.4), then it relinks to a different site. This is illustrated schematically below, where *A* represents an autosegment and *X* represents an A-bearing unit.

(60) <u>Input</u>: <u>Step (a)</u>: <u>Step (b)</u>:

$$\begin{array}{cccc} A & & A & \\ | & & | & \\ X & + & X & X \end{array} \quad \longrightarrow \quad \begin{array}{ccc} A & A & \\ | & \nmid & \\ X & X & X \end{array} \quad \longrightarrow \quad \begin{array}{ccc} A & & A \\ | & & | \\ X & X & X \end{array}$$

In keeping with the widely-held assumption that a delinked autosegment cannot relink on the same morphological cycle in which it was delinked (Pulleyblank 1986:114-16), I assume that steps (a) and (b) in (60) occur during separate cycles.

There is no clear precedence in the autosegmental literature for accounting for a clash between two identical autosegments in the above manner; I assume that this is due largely to the aforementioned ban on same-cycle relinking. Nevertheless, each of these processes (delinking under clash and linking) has been widely (but separately) utilized in order to account for various tonal phenomena. An example of the first process is Meeussen's Rule (Meeussen 1963), a tonal process in Tonga which Pulleyblank 1986 characterizes as follows:

(61) <u>Meeussen's Rule</u>: $H \longrightarrow \emptyset \; / \; \begin{array}{c} V \\ | \\ H \end{array} \; C_0 \; \begin{array}{c} V \\ | \\ \underline{\quad} \end{array}$

Since the tonal processes in Tonga are rather complex, I do not provide data or sample derivations. Instead, the reader is referred to Meeussen 1963 and Pulleyblank 1986. The point to be noted is that Meeussen's Rule constitutes an example of tonal delinking under clash. Given the view of the OCP that was presented in section 1.2.4, Meeussen's Rule may be restated simply as a repair strategy for an OCP violation that is created through morphological concatenation.

The above account of Meeussen's Rule is an example of tonal delinking in an environment analogous to stress clash, but in Tonga the delinked H-tone does not relink. In fact, I know of no tonal example which corresponds precisely to the scheme in (60). However, there are at least two examples which are nearly identical to (60). The first of these is Hewitt and Prince's 1989 analysis of tonal alternations in the perfective verbal morphology of Shona. Hewitt and Prince argue that Shona's grammar makes use of *Edge-In-Association* (Yip 1988b), which links the first and last of a string of floating autosegments from left to right and from right to left, respectively, and then links any remaining floating autosegments from left to right. In their analysis, the OCP blocks left-to-right linking of a floating H-tone (corresponding to the perfective morpheme) in certain Shona verbs but, unlike what happens in Tonga, the floating H does not disappear in these cases. Rather, it links to from right to left. This leads Hewitt and Prince to conclude that Shona's grammar invokes Edge-In-Association, and that the failure of left-to-right linking automatically triggers the application of right-to-left linking. This is analogous to the account of stress

clash resolution in (60) in that the blocking of left-to-right linking in Shona has the same explanation as the triggering of delinking in stress clash resolution: both are attributed to the OCP. The Shona example bears a further resemblance to stress clash resolution in that there is no stray erasure; the grammar provides an alternative docking point for the floating autosegment.

Ishihara 1991 describes and analyzes another tonal process, this time from Japanese compounds, which is nearly identical to (60). In this case the delinking is triggered by rule rather than by an OCP violation, but otherwise the process conforms to (60) in that the delinked tone subsequently relinks in accordance with an independently-required linking rule.

Ishihara's account is as follows. Bracket Erasure, which is how Ishihara formalizes the compounding process, creates a new phonological domain which triggers a new phonological cycle. Two independently-motivated cyclic rules then apply. The first is High Tone Delinking, and the second is Tone Association, which associates a floating tone from right to left. This is illustrated below. Following Inkelas 1989 and Ishihara 1991, [$]_P$ represents a prosodic domain.

(62) <u>Japanese Compounding</u> (Ishihara 1991):

(a) <u>Concatenation</u>:

$$\left[\begin{array}{ccc} & & H \\ & & | \\ a & t & e \end{array}\right]_P \left[\begin{array}{cc} t & u \end{array}\right] k\ e\ {}_P$$

(b) Bracket Erasure:

$$\left[\, a\ t\ \overset{\displaystyle H}{\overset{|}{e}}\ t\ u \,\right]_P k\ e$$

(c) High Tone Delinking:

$$\left[\, a\ t\ \overset{\displaystyle H}{\overset{}{e}}\ t\ u \,\right]_P k\ e$$

(d) Tone Association:

$$\left[\, a\ t\ e\ t\ \overset{\displaystyle H}{\overset{|}{u}} \,\right]_P k\ e$$

Notice that the sequence of delinking and association (i.e., linking) has the net effect of moving an autosegment from one site to another.

This same process of delinking followed by linking to another site may be used to account for the movement of stress under clash if stress is in fact autosegmental. For example, the aforementioned instance of movement under clash in Italian would be expressed as follows. First, the leftmost of two adjacent stress autosegments (made adjacent as the result of word concatenation) is forced to delink because of the OCP. Second, the delinked stress autosegment links to the leftmost available docking site as permitted by the OCP. In this case, the only acceptable docking site is the first vowel of the word, as illustrated below.

(63) Input: Delink: Relink:

$$\text{m}\overset{*}{\overset{|}{\text{e}}}\text{ta} + \text{t}\overset{*}{\overset{|}{\text{o}}}\text{rta} \longrightarrow \text{met}\overset{*}{\overset{\nmid}{\text{a}}}\ \text{t}\overset{*}{\overset{|}{\text{o}}}\text{rta} \longrightarrow \text{m}\overset{*}{\overset{|}{\text{e}}}\text{ta}\ \text{t}\overset{*}{\overset{|}{\text{o}}}\text{rta}$$

The above account of the movement of stress under clash is no different in principle than Ishihara's account of the movement of a high tone under compounding. In each case an autosegment undergoes delinking (by rule in Japanese; because of an OCP violation in Italian). In both cases the delinked autosegment subsequently relinks by rule, presumably in a later cycle. Thus, once stress shift under clash is expressed in standard autosegmental terms, it is seen to be not unlike other processes (e.g., Meeussen's Rule in Tonga, tonal alternations in Shona's perfective morphology and tonal movement in Japanese compounding) which have already been described in purely autosegmental terms.

To summarize, most of the features that are attested in stress are also attested in autosegments, and vice versa. The three exceptions are many-to-one mapping and one-to-many mapping, both of which appear to be lacking in stress systems, plus the observation that heavy syllables do not attract any other autosegment besides stress. The latter is attributed to an idiosyncrasy of stress and is left as a topic for future research. The absence of many-to-one mapping in stress systems is attributed to the fact that there seems to be only one lexical value for stress. Finally, the absence of one-to-many mapping remains to be accounted for; this problem is addressed in section 6.1.

A comparison of the features of stress and autosegments along with their respective instantiations, as discussed above, is summarized below.

(64) <u>A Comparison of Stress and Autosegments</u> (final version)

	Stress	Autosegments
Stability:	BH Arabic	Estako
Floating:	(Mayo, Tagalog)	Mende
Morphemic:	Spanish	Tiv
Polarity:	(Tagalog)	Margi
One-to-one Mapping:	(All stress systems)	Mende
Melodies:	English, Malayalam	Mende
Many-to-one Mapping:	(Needs 2 lex values)	Etsako
One-to-many Mapping:	(See section 6.1)	Mende
Attracted to heavy σ:	Huasteco	
Movement under clash:	Italian	(Delink & Relink)

The parentheses around Mayo and Tagalog indicate that the evidence for floating stress in these languages is presented in a later chapter. All of the autosegmental examples are taken from the literature on tone because autosegmental theory was first applied to tone. However, as was pointed out earlier, the conclusions are equally valid for other types of autosegments.

Contrary to virtually every theory of stress that has been proposed in recent years, the foregoing discussion has demonstrated that, except for the apparent absence of one-to-many mapping in stress systems and of heavy syllable attraction in non-stress systems, there is no basis for attributing any kind of special properties to stress. Instead, given the above conclusions that (i) stress exhibits nearly all of the properties of autosegments and (ii) autosegments exhibit nearly all of

the properties of stress, I conclude that stress belongs to the class of autosegments.

This conclusion does not imply that all stress exhibits autosegmental behavior any more than the claim that [NASAL] is autosegmental implies that it exhibits autosegmental behavior in all languages. Nor does the above conclusion imply that all autosegments are capable of functioning as stress. Rather, the conclusion to be drawn is that there is no need to appeal to specialized devices such as Stress Clash Resolution or unbounded feet in order to account for the range of stress-related phenomena. The independently-needed principles found in prosodic morphology and autosegmental theory are capable of deriving the full range of stress-related phenomena without referring to any other principles.

What, then, is stress? As I have defined it, stress is a means of marking prominence which utilizes no more than one underlying autosegment. This definition does not mention feet because, as was argued earlier, the latter are attested in some but not all stress systems. Where feet are required, their role is to provide a domain for inserting a stress autosegment. This is further explained below and in chapter 3.

The above definition implies that stress is capable of exhibiting the kinds of formal behavior that would be expected of a single-valued tonal system, and yet it is not required to behave like tone in every language. This is because the definition simply states that stress is an autosegment; it does not equate stress with tone any more than [ATR] is equated with tone.

Further questions eventually need to be addressed. For example, is there a unique stress autosegment which is used only in stress systems, or do stress systems simply make use of the general inventory of autosegments such as [TONE], [NASAL], [ATR], etc.? If the latter is the case, then an explanation must be found as to why certain autosegments such as [NASAL] and [ATR] never seem to function as stress. If, on the other hand, there is a unique stress autosegment, how is it different from all other phonological features, and why doesn't it function outside of stress systems? In the interest of limiting the length of this study, I leave these questions for future research. For now, I conclude only that the formal behavior of stress conforms to the principles of autosegmental theory. Specifically, stress is an autosegment.

The next section proposes a new approach to stress assignment based upon the separation of metrical constituents and stress and the autosegmental nature of the latter.

2.3. The Basic Proposal.

The preceding sections outlined the properties of stress and compared them with the formal properties of autosegments, concluding that stress is in fact autosegmental. The task, now, is to extend this conclusion to a new theory of stress assignment and demonstrate that the new theory is capable of generating all the varieties of stress that have been observed without generating any unattested stress patterns.

Therefore, the present section is organized as follows. Section 2.3.1 presents the *Autosegmental Stress Hypothesis*, which formalizes the

autosegmental nature of stress as the foundational principle of this new theory, and briefly reviews the arguments for this principle. Section 2.3.2 discusses the typology of binary stressed feet that is predicted by combining the Autosegmental Stress Hypothesis with the proposed inventory of primitive feet. This typology is divided into two groups, symmetric and asymmetric feet. Symmetric stressed feet, which contain exactly two identical constituents, are further subdivided into syllabic and moraic feet. The instantiation of each of these stressed foot types is presented in chapter 3. Finally, section 2.3.3 presents four additional principles that are invoked in the following chapters. These include (i) the Foot-as-Domain Principle, which allows the foot to serve as a domain for the application of phonological rules, (ii) the Weight-to-Stress Principle (Kager 1989, Prince 1990), which allows a grammar to link stress directly to heavy syllables, (iii) the Degenerate Foot Principle, which concerns the interaction of foot-building with lexical accent, and (iv) the Uniform Linking Constraint (based on the Uniform Headedness Constraint; see Halle and Vergnaud 1978, Stowell 1979, Hammond 1990b), which requires that all stressed feet in any given word agree in terms of which edge of the foot the stress is linked to.

I begin by formalizing the proposed manner in which autosegmental stress interacts with feet.

2.3.1. The Autosegmental Stress Hypothesis.

Section 2.1 concluded that a new theory of stress is needed, one in which constituency and prominence are formally separate. This might

seem like a tall order, but in fact the needed mechanisms are already available in two separate, well-established theories: prosodic morphology and autosegmental phonology. As was pointed out in section 2.1, prosodic morphology differs from most approaches to metrical theory primarily in that the latter always assign heads to feet while the former does not. The section went on to argue that there is no evidence that metrical heads are ever required. Instead, the feet used in stress systems may be assumed to be headless; stress is then viewed simply as a phonological feature rather than as an inherent element of a foot. Section 2.2 went on to demonstrate that stress behaves formally as an autosegment. This approach to stress assignment, which constitutes the central proposal of this study, is stated in (65) as the *Autosegmental Stress Hypothesis*.

(65) Autosegmental Stress Hypothesis: Stress is an autosegment.

The validity of the Autosegmental Stress Hypothesis depends, in part, upon the separation of *constituency* (i.e., foot-building) from *prominence* (i.e., stress). As was pointed out earlier, this idea is not entirely new. For example, H&V also separate constituency from prominence in their theory of stress, as indicated by the following quote:

> "Following an idea originating with Liberman (1975), we propose to treat stress by means of the same basic formalism as tone: we shall set up a special autosegmental plane on which one line will contain the sequence of phonemes and a second line will consist of a sequence of marks representing the stressed phonemes. This formalization will allow us to account for the fact that stress, or the absence thereof, is a property that is associated in general with discontinuous subsequences in the string of phonemes. We shall represent

> the autosegmental line for stress as a sequence of abstract positions or slots associated with the stress-bearing units on the central line. A slot corresponding to a stressed element will be filled by an asterisk." (Halle and Vergnaud 1987b, page 5).

Notice that H&V base their proposal in large part upon autosegmental theory. Nevertheless, they stop short of rigorously adhering to the established principles of autosegmental theory because of some alleged differences between stress and the classic autosegment, tone. First of all, H&V claim that tone, but not stress, "is associated with units identified by their phonetic substance and which partakes of this phonetic substance" (page 6). However, this is not necessarily true. The fact that stress may arguably not have a specific phonetic reflex is completely compatible with an abstract (but specific) stress autosegment.

As another difference between stress and tone, H&V cite the fact that two successive stresses may be (and usually are) separated by one or more potential stress-bearers, whereas two successive tonal autosegments will always occupy successive tone-bearing slots. What H&V fail to notice, however, is that the latter situation arises only when the adjacent tones are either non-identical or in different morphemes. When this fact is taken into account, the alleged difference between tone and stress disappears, for two stresses can indeed occur on adjacent stress-bearing units under exactly the same conditions, i.e., when the two stresses are either non-identical or in different morphemes. The latter case produces an OCP violation which must be resolved, as was discussed in sections 1.2.4 and 2.2.3.

It should also be noted that the domain of stress placement is normally the foot, and stress occurs at the edges of feet in the same sense that tone (as viewed by most tonologists) occurs at the edges of words.[35] When this point is considered, the behavior of stress is seen to be very similar to the behavior of tone (and all other autosegments) in that both occur at domain edges.

As was noted in section 2.2.3, there are some differences between the behavior of tone and the behavior of stress, but these differences are largely irrelevant to the claim that stress is an autosegment. The only exception is that stress is not observed to spread; this is discussed in section 6.1.

In summary, the Autosegmental Stress Hypothesis is a logical extension of H&V's idea of treating stress by means of the same basic formalism as tone. That is, the Autosegmental Stress Hypothesis is implicit in H&V's theory of stress, but H&V apply it only in limited ways.

Next, I propose a typology of primitive feet similar to that of Hayes 1987, 1991 but crucially differing from Hayes' theory in that the feet I propose are inherently headless. Applying the Autosegmental Stress Hypothesis to this typology produces a set of stressed feet which is equivalent to Hayes' inventory of metrical feet except for two additional stressed feet which are not predicted by Hayes' theory.

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[35]It would not be true that stress is assigned to the edge of a foot in languages with [-HEAD TERMINAL] feet, as proposed by Halle and Vergnaud 1987b for Cayuvava. However, the existence of such feet is very much in dispute. See, for example, Hammond 1990a and b.

2.3.2. The Typology of Stress.

The preceding section proposed, based on the conclusions of the earlier sections of this chapter, that stress is an autosegment. This conclusion does not preclude the use of feet in stress assignment but, as was argued in section 2.1, there is no reason to posit the existence of heads in those feet. Consequently, I henceforth treat foot-related stress assignment as an interruptible sequence of two independent processes. The first of these is the construction of inherently headless (and stressless) feet, and the second consists of inserting some autosegment into the foot and, in some cases, into some other prosodic domain as well. (Recall from section 2.1.1 that some stress systems do not refer to feet at all). The next task is to specify what kinds of primitive (i.e., stressless) feet are available and what those feet might look like after stress has been assigned to them. Accordingly, this section first considers the typology of primitive stressless feet, followed by the typology of stressed feet which results from all the possible ways in which a stress autosegment may be inserted and linked in a primitive foot.

2.3.2.1. The Typology of Primitive Feet.

As chapter 1 pointed out, Hayes 1991 proposes that there are only three types of binary feet: the syllabic trochee, the moraic trochee and the iamb. Throughout this study, I assume Hayes' typology with one important modification: feet are inherently headless. Therefore, since the term *trochee* implies left-headedness, I refer to symmetric feet sim-

ply as syllabic feet and moraic feet rather than syllabic trochees and moraic trochees, respectively. These two primitive foot types are represented in (66).

(66) <u>Inventory of Primitive Symmetric Feet</u>:

Syllabic Foot: $(\sigma\ \sigma)$ Moraic Foot: $(\mu\ \mu)$

In what follows I claim, contrary to Hayes 1991, that stress may be assigned to either edge of either one of these primitive symmetric foot types. In the case of the iamb, however, the Weight-to-Stress Principle (Kager 1989, Prince 1990) ensures that it will always be right-stressed in those cases where it has a stress. This is because the rightmost constituent is, by definition, the heavier member of an iambic foot. Thus, while it is possible to have a stressless iambic foot (e.g., McCarthy and Prince 1990 argue for such a foot in Arabic), there is only one place where a stress can link after it has been inserted into an iambic foot; this is illustrated in the next section and again in chapter 3.

The foregoing discussion is explicitly limited to *binary* feet in that it does not necessarily apply to ternary feet. As was mentioned earlier, the existence of such feet is in dispute. A possible means of applying my proposal to derive the effect of ternarity is presented in Hagberg 1992.

To summarize, I assume Hayes' 1991 primitive typology of binary feet, with the exception that feet are inherently headless. Next, I

discuss the typology of stressed feet which results from adding autosegmental stresses to primitive binary feet.

2.3.2.2. The Typology of Binary Stressed Feet.

The claim that feet are inherently headless accounts for the lack of evidence for metrical heads in morphological processes, as was argued in section 2.1, but it also makes some predictions that are not made by the theory of Hayes 1991. Most notably, the inherent headlessness of feet, together with the claim that stress is an autosegment, predicts that five different combinations of binary feet with autosegmental stress are possible. These are presented in schematic form in (67), where the symbol * represents a stress autosegment.

(67) The Predicted Surface Typology of Binary Stressed Feet:

(a) Syllabic, Left-stressed:

```
 *
 |
(σ σ)
```

(b) Syllabic, Right-stressed:

```
   *
   |
(σ σ)
```

(c) Moraic, Left-stressed:

```
 *
 |
(μ μ)
```

(d) Moraic, Right-stressed:

```
   *
   |
(μ μ)
```

(e) <u>Iambic</u>: <u>Preferred</u>: <u>Else</u>:

$$\begin{array}{ccc} \ast & & \ast \\ | & & | \\ (\mu\ \sigma_{\mu\mu}) & & (\mu\ \mu) \end{array}$$

In the case of an iambic foot of the form (μ μ), I assume that stress always links to the rightmost member in order to conform to the direction of linking in the preferred (i.e., asymmetric) iambic foot. This is explained in section 2.3.3.2, where the mechanism by which stresses are assigned to iambic feet is formalized.

Each of the symmetric stressed foot types in (67) is instantiated with language data in chapter 3. The two types of syllabic feet are exemplified with Warao and Mayo, which are left-stressed and right-stressed, respectively. The two types of moraic feet are exemplified with Cairene Arabic and exceptionally stressed Turkish words, which are left-stressed and right-stressed, respectively. Hixkaryana was already discussed in chapter 1 as an example of a language which utilizes the iambic stress foot.

Having thus developed the autosegmental theory of stress, the next three chapters instantiate this theory and apply it to several stress systems which prove difficult to analyze under other theories of stress. First, however, this chapter concludes by presenting some additional principles which are utilized in the remaining chapters.

2.3.3. Further Principles Needed for the Proposal.

The preceding discussion argued for the Autosegmental Stress Hypothesis, which claims that stress is an autosegment. This is the key

proposal of the present study, and a number of arguments in support of this conclusion remain to be presented. Before going on to chapter 3, however, there are four additional principles which, although largely independent of my central proposal, nevertheless play important roles in the analyses that are presented in the ensuing chapters. These principles concern (i) the concept of the foot as a domain for the application of autosegmental processes (Foot-as-Domain Principle), (ii) the linking of stress directly to heavy syllables (Weight-to-Stress Principle), (iii) the interaction of lexical accent with foot-building (Degenerate Foot Principle), and (iv) the Uniform Linking Constraint (adapted from the Uniform Headedness Constraint of Stowell 1979, Halle and Vergnaud 1987, Hammond 1990b), which requires all of the stressed feet in a word to be stressed on the same edge at any given point in the derivation. The first three of the above principles define the three ways in which individual stresses may be linked within feet, whereas the Uniform Linking Constraint is a universal constraint on word-level representations. Each of these is discussed in turn below.

2.3.3.1. The Foot-as-Domain Principle.

The concept of *domains* is inherent in all versions of lexical phonology. Simply stated, a domain is that entity, defined in phonological, morphological and/or syntactic terms, in which phonological rules operate. For example, the terms *lexical* and *postlexical* generally reflect a distinction between rules which apply to words and rules which apply to phrases, respectively. The innovative aspect of my proposal,

with respect to the concept of domains, is that the foot constitutes a legitimate domain for the application of phonological rules; this is henceforth referred to as the *Foot-as-Domain Principle*. In particular, I assume that any set of rules of stress assignment must conform to the established principles of autosegmental theory. This means that the relationship between a stress autosegment and the foot in which it ends up is formally identical to the relationship between a tonal autosegment and the domain in which it ends up in a language such as Mende, Etsako or Tiv.

The use of Foot-as-Domain for inserting and linking autosegmental stress was illustrated schematically in the preceding section. The application of this principle to actual languages is illustrated in chapter 3.

2.3.3.2. The Weight-to-Stress Principle.

As section 2.1.1 pointed out, Prince 1990 argues for the Weight-to-Stress Principle, restated in (68), based largely on the observation that unbounded feet, if they exist, should be available to function in templatic morphological processes such as reduplication, just as binary feet have been observed to do. Since this appears to be unattested, Prince concludes that unbounded feet do not exist. Instead, he claims that the effect of unbounded stress is achieved in languages such as Huasteco and Khalkha Mongolian by assigning stress directly to heavy syllables without the use of feet.

(68) Weight-to-Stress Principle (Prince 1990): If heavy, then stressed.

Kager 1989 also proposes the Weight-to-Stress Principle as a well-formedness condition on the output of representations in Dutch and English.

In this study, I apply the Weight-to-Stress Principle in three ways. First, at the word level, Weight-to-Stress is an option which individual grammars may invoke so as to derive what has generally been referred to as unbounded stress; this process makes no reference to metrical structure. However, it is also possible for a grammar to apply Weight-to-Stress within the foot in one of two ways. First, a grammar may optionally apply Weight-to-Stress to a footed string. This differs from unbounded stress systems in that disyllabic feet are required, but it also differs from quantity insensitive stress systems in that stress is attracted to heavy syllables. Crucially, Weight-to-Stress does not apply to unfooted heavy syllables in such a language.

The other way in which a grammar may choose to apply Weight-to-Stress within the foot is to define the foot as iambic, in which case Weight-to-Stress is the only means by which stress may be assigned.

Each of these ways of applying the Weight-to-Stress Principle is discussed below. I begin with the word level.

Whenever a grammar invokes Weight-to-Stress at the word level, it must choose a setting for each of two parameters. First, Weight-to-Stress may apply either from left to right or from right to left. Second, it may apply either iteratively or non-iteratively. If it is iterative, then every heavy syllable in the domain will be stressed, but if it is non-iterative, then only the leftmost or rightmost heavy syllable

will be stressed, depending on the setting of the directionality parameter. The use of these parameters is illustrated schematically below, where $\mu\mu$ and μ represent a heavy syllable and a light syllable, respectively.

(69) <u>Left to Right; Non-iterative</u>:

```
                          *
                          |
μ μμ μ μμ μ  —>  μ μμ μ μμ μ
```

(70) <u>Right to Left; Non-iterative</u>:

```
                                *
                                |
μ μμ μ μμ μ  —>  μ μμ μ μμ μ
```

(71) <u>Left to Right; Iterative</u>:

```
                          *                          *      *
                          |                          |      |
μ μμ μ μμ μ  —>  μ μμ μ μμ μ  —>  μ μμ μ μμ μ
```

(72) <u>Right to Left; Iterative</u>:

```
                                *                    *      *
                                |                    |      |
μ μμ μ μμ μ  —>  μ μμ μ μμ μ  —>  μ μμ μ μμ μ
```

Notice that the final outputs in (71) and (72) are the same. Different results might be expected when two heavy syllables are adjacent. In that case, the OCP might be expected to block the second application of Weight-to-Stress, so directionality would be relevant. (Of course, the OCP would come into play only if stress links to the syllable and not to the mora; I leave this as an open question). Otherwise, the setting of

the directionality parameter is irrelevant when Weight-to-Stress applies iteratively to a word in which there are no adjacent heavy syllables.

In each of the preceding examples, the domain in which the Weight-to-Stress Principle applied was the word. However, it is also possible for a grammar to apply Weight-to-Stress within a foot in one of two ways. First, a grammar may opt to apply Weight-to-Stress directionally to a word, as in the above examples, but with the added stipulation that the target must be a terminal element of a foot. Chapter 4 applies Weight-to-Stress in this manner in the analyses of Yidin^y and Capanahua.

Finally, some grammars build iambic feet, i.e., feet whose right terminal element is required (or preferred) to be heavy. In these languages, the application of Weight-to-Stress is obligatory and the domain in which it applies is the foot. Iterativity is not relevant since an iambic foot has at most one heavy syllable. Directionality is relevant, but this is only because it is the right member of the foot that is heavy in the preferred iamb.[36] In order to avoid violating the Weight-to-Stress Principle in a system that utilizes iambic feet, the direction of linking has to be from right to left. (I assume that this direction applies to all iambic feet, including those which do not contain a heavy syllable; see the discussion below). In other words, in this case the Weight-to-Stress Principle overrides the otherwise-independent ability

[36]Recall that I am assuming Hayes' 1991 inventory of primitive feet, minus the heads. In this system, the iamb is the only foot in which the Weight-to-Stress Principle obligatorily applies. Left-stressed asymmetric feet, if they exist, would be handled in the same manner as iambs, and applying Weight-to-Stress in a foot of the form [$\mu\mu$ $\mu\mu$], if it exists, would be equivalent to setting the directionality parameter without applying Weight-to-Stress.

of grammars to select either direction of autosegmental linking. This is illustrated below.

(73) Domain = Canonical Iambic Foot:

In (μ $\mu\mu$), Weight-to-Stress applies; directionality is irrelevant:

$$(\mu\ \mu\mu) \longrightarrow (\mu\ \overset{\overset{*}{|}}{\mu\mu})$$

Although the Weight-to-Stress Principle forces *some* feet to be right-stressed, it cannot directly account for the stress patterns of *all* putatively iambic feet, for in some cases iambic feet have the form (μ μ). Consequently, it must be assumed that the stress pattern of canonical iambs, which is determined entirely by the Weight-to-Stress Principle, forces the stress autosegment to link to non-canonical iambs from right to left. This interplay of Weight-to-Stress and directionality in non-canonical iambic feet is summarized below.

(74) Domain = Non-canonical Iambic Foot:

In (μ μ), Weight-to-Stress is inapplicable, but * is inserted and links from right to left in order to conform to the stress pattern of canonical iambs:

$$(\mu\ \mu) \longrightarrow (\mu\ \overset{\overset{*}{|}}{\mu})$$

Notice that the two parameters of Weight-to-Stress -- directionality and iterativity -- are common to virtually all autosegmental rules. It is only the *target* of Weight-to-Stress, i.e., the heavy syllable, which is not commonly invoked in autosegmental rules. As stated in sec-

tion 2.2.1, I assume that this is simply an idiosyncratic feature of the stress autosegment.

The Weight-to-Stress Principle is used to derive unbounded feet in a number of languages in sections 3.2 and 4.2.

Next, I discuss the interaction of foot-building with lexical accent.

2.3.3.3. The Degenerate Foot Principle.

We now come to what is perhaps the most innovative aspect of my proposal. As was indicated in the preceding discussion, the facts of Mayo stress and reduplication together make it necessary (or at least desirable) to assume the *Degenerate Foot Principle*, stated below.[37]

(75) Degenerate Foot Principle: During foot-building, the presence of a stress autosegment linked to any element that is being incorporated into a foot forces that foot to become degenerate.

The application of the Degenerate Foot Principle is illustrated schematically below.

(76)
$$\begin{array}{lllllllllll} * & & & & * & & & & * & & \\ | & & & & | & & & & | & & \\ \sigma & \sigma & \sigma & \rightarrow & (\sigma) & \sigma & \sigma & * & (\sigma & \sigma) & \sigma \end{array}$$

---

[37]It may be possible to derive the Degenerate Foot Principle from the Uniform Linking Constraint (discussed in the next section) for, if a binary foot were to be built around a stressed element, the direction of linking would be determined by the location of that particular stressed element rather than by the grammar. If, on the other hand, a unary foot were to be built in that instance, it would have no effect on the direction of linking. I do not pursue this idea here.

As far as I can tell, this kind of innovation is required of any theory that would attempt to account for the Mayo data that are presented in chapter 5. Furthermore, the facts of Macedonian stress are consistent with the Degenerate Foot Principle. Section 2.1.1 argued that words with exceptional final stress must have a degenerate (i.e., monosyllabic) foot (if they have any foot structure at all), and the formation of that degenerate foot can be attributed only to the presence of lexical accent.

The motivation for the Degenerate Foot Principle comes from the fact that Mayo's base of reduplication consists of a disyllabic foot for unaccented words and a single syllable for accented words; the evidence for this conclusion is presented in section 5.1.2. In order to treat both accentual classes in a uniform manner, it is necessary to assume that accented words have a degenerate foot at the point in the derivation when reduplication applies.

It should be emphasized that this approach does *not* entail any claim regarding what might happen to previously-constructed feet when autosegmental stresses are assigned to them. That is, the Degenerate Foot Principle claims only that a linked stress autosegment may affect the process of foot-building, just as certain segmental features may directly influence the process of syllabification.[38] The Degenerate Foot Principle does *not* claim that the assignment of stresses to previ-

---

[38]For example, many languages have constraints on what features may be present in syllable codas. See Ito 1986, 1989 for a discussion of this type of phenomenon.

ously-constructed feet triggers any change in the boundaries of those feet.

In summary, the Degenerate Foot Principle, like the Weight-to-Stress Principle, reflects a property that is unique to the stress autosegment. The Degenerate Foot Principle simply says that any rule of foot-building must build a degenerate foot whenever it encounters a linked stress autosegment.

2.3.3.4. The Uniform Linking Constraint.

Halle and Vergnaud 1978 and Stowell 1979 observe that it seems to be the case across languages that all feet within any given word agree in headedness at the output of the derivation. Hammond 1990b formalizes this generalization as the *Uniform Headedness Constraint*, which he invokes in the analysis of Yidin^{y}.

This study adopts Hammond's idea. In my terms, however, *headedness* can refer only to the direction of linking of the stress autosegment since I have already argued against the existence of metrical heads. Accordingly, I henceforth use the term *Uniform Linking Constraint* rather than Uniform Headedness Constraint.

The Uniform Linking Constraint prohibits (at all levels of representation) representations such as the following, where X represents any element of a foot (i.e., either σ or μ):

(77) $$* \left[\begin{array}{ccc} * & & * \\ | & & | \\ (X\ X) & \ldots & (X\ X) \end{array}\right]_{\text{word}}$$

The problem with (77) is that a single word contains two stressed feet in which the stress autosegment is linked to opposite edges; one foot is left-stressed and the other is right-stressed. No matter where they occur within the word, the Uniform Linking Constraint prohibits the simultaneous existence of both types of stressed feet.

Notice that the Uniform Linking Constraint concerns only the relationship between stress autosegments and feet. No claim is being made regarding other autosegments besides stress, nor is it claimed to apply to the relationship between stress and any other domain besides the foot.

The Uniform Linking Constraint is nothing more than a reflection of the basic role which the foot plays in a number of stress systems, and it actually follows from a more general principle. To see this, consider the following. In order for the foot to be a relevant part of a grammar, there must be evidence for some specific foot structure in the output; Halle and Vergnaud 1987b formalize this as the *Recoverability Condition*. Now, if a grammar were to include a rule linking stress to feet without simultaneously requiring those feet to adhere to the Uniform Linking Constraint, the evidence for the role of the foot in stress assignment would be highly obscure at best. Why? Because stress cannot serve as a diagnostic for the presence of feet unless there is some kind of regularity to the stress pattern within a given word. If stress were permitted to surface on the left edge of one foot and on the right edge of another foot within the same word, as illustrated in (77), then foot structure could not be deduced from the locations of stress,

and the Recoverability Condition would be violated. Thus, the Uniform Linking Constraint follows from H&V's Recoverability Condition. To the extent that the latter is a valid part of universal grammar, the Uniform Linking Constraint is also valid.

The Uniform Linking Constraint is invoked in the analysis of Yidin^y in section 4.2, where it is argued that the direction of linking (within the foot) is from left to right unless this would result in a word whose feet are non-uniformly stressed. If the latter is the case, then linking will occur from right to left in order to conform to the direction of linking in the first foot that was stressed.

In conclusion, the Uniform Linking Constraint prohibits the existence, at any level of representation within a single word, of two stressed feet in which the stress autosegment is linked to opposite edges. The Uniform Linking Constraint actually follows from H&V's more general Recoverability Condition.

2.4. Summary.

This chapter began by defining the concepts of metrical head and stress. It was argued that, since stress is the only diagnostic for the presence of a metrical head, the latter is redundant and should be eliminated from phonological theory. It was then argued, on the basis of the theory of prosodic morphology as well as on the basis of the facts of Yidin^y stress, that feet can exist apart from stress. I then explored the hypothesis that stress is autosegmental. After reviewing the properties of autosegments and comparing those properties to the list of

properties of stress that was compiled earlier, and after eliminating those differences that pertain only to phonetic substance and not to formal behavior, it was concluded that the formal behavior of stress is identical to the formal behavior of autosegments. That is, stress is an autosegment.

This conclusion was then formalized as the Autosegmental Stress Hypothesis. It was argued that this hypothesis is a logical extension of H&V's idea of treating stress by means of the same basic formalism as tone, although H&V apply this idea only in limited ways.

Next, I proposed a typology of primitive feet similar to that of Hayes 1987, 1991 but differing from Hayes' theory in that my feet are inherently headless. The Autosegmental Stress Hypothesis was applied to this typology, producing a set of stressed feet which is equivalent to Hayes' inventory of metrical feet except for two additional stressed feet which are not predicted by Hayes' theory.

Finally, I presented four basic principles that are assumed in the remaining chapters. These included the Foot-as-Domain Principle, the Weight-to-Stress Principle, the Degenerate Foot Principle and the Uniform Linking Constraint. The latter is a universal constraint on word-level representations which follows from H&V's Recoverability Condition; it is required by other theories of stress as well. The remaining three principles define the three ways in which individual stresses may be linked within feet. The Weight-to-Stress Principle additionally makes it possible to account for unbounded stress systems without the use of feet. By assuming that stress is an autosegment distinct from tone and

other autosegments, it is possible for these special principles to apply uniquely to stress (although the Foot-as-Domain Principle applies to other autosegments as well) just as other principles apply only to certain other autosegments.

The chart in (78) summarizes the typology of prominence that is predicted by autosegmental theory in conjunction with the Foot-as-Domain Principle and the Weight-to-Stress Principle. All of the languages listed as examples in (78) were discussed earlier with the exception of Old English. Based on the existence of various foot-based rules in Old English, Dresher and Lahiri 1991 argue for a new foot type. However, Hagberg (in prep) argues that the foot-based rules may be accounted for using a headless bimoraic foot, and that stress is derived via a rule which inserts and links a stress autosegment directly to the word from left to right. Thus, Old English instantiates a language whose grammar builds feet which are irrelevant to stress assignment, for the domain of the latter is the word rather than the foot.

(78) Word and Foot as Domains of Stress Assignment:

	Foot-Building: Yes	Foot-Building: No
Stress Domain: Word	Old English	Huasteco
Stress Domain: Foot	Warao, C. Arabic	(Not possible)

Huasteco is listed as an another example of a language whose grammar utilizes the word as the exclusive domain into which stress is inserted and linked. Unlike Old English, however, Huasteco exhibits no

evidence of foot structure. Furthermore, the Huasteco stress pattern is derived via the application of Weight-to-Stress; sample derivations are given in section 3.2.

(78) lists Warao and Cairene Arabic as examples of traditional stress languages; all such languages use the foot as the primary domain in which stress assignment occurs. The autosegmental analyses of these stress systems are presented in section 3.1.

The next chapter instantiates the typology of stressed feet that was presented in section 2.3.2 as well as the predicted typology of Weight-to-Stress, thus supporting the claim that the autosegmental theory of stress is capable of generating all of the varieties of stress that have been observed without generating any unattested stress patterns.

CHAPTER 3

INSTANTIATING THE TYPOLOGY OF STRESS

The preceding chapter argued for the inherent headlessness of all feet and the autosegmental nature of stress; the latter claim was formalized as the Autosegmental Stress Hypothesis. The primary task of the remaining chapters is to demonstrate that all and only those stress systems which are predicted by this theory are actually attested. Chapters 4 and 5 are largely devoted to exploiting the Autosegmental Stress Hypothesis in the analysis of data that are problematic for other theories of stress. Before proceeding to these more complex cases, however, this chapter instantiates the basic typology that is predicted by the Autosegmental Stress Hypothesis. For each language that is considered, the autosegmental analysis is compared to other proposals that have been made for that stress system. In some cases, most notably for Mayo and Turkish, it is shown that the autosegmental approach is able to avoid certain *ad hoc* devices which are required by other theories.

Therefore, the present chapter is organized as follows. Section 3.1 instantiates the typology of binary stressed feet with data from five languages. This typology is divided into two groups, symmetric and asymmetric stressed feet. Symmetric stressed feet, which always contain exactly two identical constituents, are further subdivided into syllabic and moraic stressed feet. Section 3.2 illustrates the derivation of 'unbounded' stress systems via the application of Weight-to-Stress in the word domain. It is argued that all and only those 'unbounded' sys-

tems which are predicted by the autosegmental theory of stress are actually attested.

3.1. The Typology of Binary Stressed feet.

The Autosegmental Stress Hypothesis implies that stress may be inserted by rule into a foot and linked to either edge of that foot regardless of the foot's composition, just as any autosegment may in principle be inserted and linked by rule to either edge of any domain. Assuming the primitive inventory of stressless binary feet (syllabic, moraic and asymmetric) that was proposed in section 2.3.2.1, there are six logically possible ways to combine these feet with a stress autosegment; these are listed in (1).

(1) Predicted Inventory of Stressed Feet:

Left-Stressed Syllabic	Right-Stressed Syllabic
Left-Stressed Moraic	Right-Stressed Moraic
Left-Stressed Asymmetric	Right-Stressed Asymmetric

With the exception of the left-stressed asymmetric foot, each of the combinations in (1) is instantiated below.[1] Section 3.1.1 presents Warao and Mayo as examples of languages with left-stressed and right-

[1]I know of no language in which the left member of the foot is required to be heavy. Dresher and Lahiri 1991 propose such an analysis for Old English, but Hagberg (in prep) proposes an alternative analysis which uses symmetric feet. I assume that the absence of left-stressed asymmetric feet is due to extralinguistic principles of rhythm, as argued in Hayes 1987.

stressed syllabic feet, respectively. Mayo's right-stressed syllabic foot is not included in Hayes' 1991 foot typology, but it is argued that this foot type is required in order to account for the Mayo data. Section 3.1.2 presents Cairene Arabic and Turkish as examples of languages with left-stressed and right-stressed moraic feet, respectively. The autosegmental analysis of Cairene Arabic is compared to other analyses that have been proposed in Halle and Vergnaud 1987b, Halle 1990 and Hayes 1991, arguing that these analyses are notationally equivalent to one another in most respects. The autosegmental analysis of Turkish is compared to the analyses found in Kaisse 1985, Hammond 1986, Halle and Vergnaud 1987b and Hayes 1991. It is argued that the autosegmental analysis of Turkish captures the facts in a uniform manner whereas the other analyses do not. Finally, section 3.1.3 discusses Hixkaryana as an instance of a language with right-stressed asymmetric (i.e., iambic) feet.

3.1.1. Syllabic Feet.

Syllabic feet, as the name implies, consist of two syllables; syllable weight does not play a role in their construction. Warao is discussed first as a simple example of a language in which a stress autosegment links to syllabic feet from left to right. Mayo is then presented as a language whose stressed feet are the mirror image of stressed feet in Warao. That is, whereas Warao exhibits left-stressed syllabic feet, Mayo has right-stressed syllabic feet. Hayes 1991 claims that this foot type does not exist, but its existence is predicted by

the autosegmental theory of stress. Furthermore, it is pointed out that approximately half of Mayo's words have a lexical accent which exhibits autosegmental behavior. This constitutes another argument for the claim that stress is autosegmental.

3.1.1.1. The Stress Pattern of Warao.

The stress system of Warao provides a simple example of the assignment of a stress autosegment to purely syllabic binary feet. Primary stress in Warao falls on the penultimate syllable in most words, and secondary stress occurs on every other syllable preceding primary stress, as illustrated in (2).[2]

(2) Warao (Osborn 1966):

tíra	*woman*
apáu	*well placed*
koránu	*drink it!*
rùhunáe	*he sat down*
yiwàranáe	*he finished it*
nàhoròahàkutái	*the one who ate*
yàpurùkitànehá se	*verily to climb*

This pattern is accounted for by the following set of rules:

[2]Osborn reports a few instances of primary stress occurring on the final syllable or on the antepenultimate syllable, but the alternating secondary stresses are always determined by the placement of primary stress. I assume that the instances of exceptional final stress may be accounted for by the presence of lexical accent on the final syllable, and the instances of antepenultimate stress seem to be conditioned by the morphology, i.e., certain suffixes apparently enter the derivation after foot-building has applied.

(3) <u>Stress Assignment in Warao</u>:

(a) Build syllabic feet iteratively from right to left.

(b) Insert * in each foot and link from left to right.[3]

Words containing an even number of syllables will be exhaustively footed, as illustrated in (4).[4]

```
(4) Input:              Build Feet:          Insert & Link *:   Output:

                                              *       *
                                              |       |
     σ   σ   σ σ        (σ   σ) (σ σ)        (σ   σ) (σ σ)
    /|  /|  /| |        /|  /|  /| |         /|  /|  /| |
    r u h u n a e       r u h u n a e        r u h u n a e      rùhunáe
```

However, any word that has an odd number of syllables will end up with an unfooted initial syllable, as in (5).

```
(5) Input:              Build Feet:          Insert & Link *:   Output:

                                                 *
                                                 |
     σ   σ   σ           σ  (σ   σ)           σ  (σ   σ)
    /|  /|  /|          /|  /|  /|           /|  /|  /|
    k o r a n u         k o r a n u          k o r a n u        koránu
```

Recall from chapter 1 that Hayes 1991 accounts for the Warao stress pattern in essentially the same way, except for the fact that

---

[3]Strictly speaking, this step should be broken down into two separate rules, one which inserts * and another which links * from left to right. Here and elsewhere, for convenience and in the absence of evidence for intervening rules, I collapse these into a single statement.

[4]In order to derive the difference between primary and secondary stress, a right-stressed word tree may be built on top of the stresses in the output of (4). Since this is not the focus of the present study, the formalization of this process is deferred until sections 3.2 and 6.1.

Hayes utilizes inherently headed feet rather than using headless feet and assigning stresses to them in a separate step as I have done. The Warao data do not seem to provide any means of testing between these two approaches to stress assignment.

Thus, Warao may be viewed as a language in which syllabic feet are built iteratively from right to left and a stress autosegment is inserted into each foot and linked from right to left.

3.1.1.2. The Basic Stress Pattern of Mayo.

Mayo is a Uto-Aztecan language of northwestern Mexico. Although a number of works have been published concerning the morphology and syntax of Mayo and the closely related Yaqui language, very little attention has been given to the phonology of these two languages.[5] Therefore, the Mayo data that are presented here are primarily from my personal field notes which were collected in a number of villages of the Mayo River valley and Fuerte River valley between 1983 and 1990 under the auspices of the Summer Institute of Linguistics. Some of the data are additionally found in Collard and Collard 1962.

Although vowel length is a feature of many Mayo words, its presence greatly complicates the analysis of stress. Therefore, the discussion of vowel length is deferred until chapter 5, and the present

[5]For studies in the morphology and syntax of Mayo and closely related languages, see Buelna 1890, Hilton 1959, Collard and Collard 1962, Johnson 1962, Lindenfeld 1973, Brambila 1976, Langacker 1977, Lionnet 1977, Miller 1989 and Escalante 1990. Regarding the phonology of Mayo and its close relatives, see Fraenkel 1959, Crumrine 1961, Seiler 1965, Burgess 1970, Stoltzfus 1979, Willet 1982, Burnham 1988 and Hagberg 1989a, 1989b and 1990.

section deals only with words having all short vowels. All such words have a single stress on either the first or second syllable; there is no secondary stress. The only acoustic feature that can be attributed to stress is high pitch, and there appears to be no systematic difference in the level of pitch on a word-initial stressed syllable versus the pitch on a non-initial stressed syllable. That is, the phonetic realization of stress seems to be independent of its position in the word.[6]

The basic paradigm for Mayo stress is presented in (6) through (13). Consider first the three forms in (6). Notice that each has the same stem *chúpnake* 'will harvest', and that stress falls on the first syllable in each word even when that syllable is a prefix. The same is true of the sets of forms in (8), (10) and (12): stress falls on the first syllable in every case.

First Syllable Stress:			Second Syllable Stress:		
(6)	chúpnake	will harvest (tran)	(7)	ponnáke	will play (tran)
	híchupnake	will harvest (intr)		hipónnake	will play (intr)
	híhichupnake	will always harvest		hihíponnake	will always play
(8)	bwá'anake	will eat (tran)	(9)	ba'áte	irrigate (tran)
	hí'ibwanake	will eat (intr)		hibá'ate	irrigate (intr)
	híhi'ibwanake	will always eat		hihíba'ate	always irrigate
(10)	chíknake	will sweep (tran)	(11)	wiséka	sawing (tran)
	híchiknake	will sweep (intr)		hiwíseka	sawing (intr)
	híhichiknake	will always sweep		hihíwiseka	always sawing

[6]Hagberg 1988b is an instrumental study which demonstrates the general validity of this claim. However, the data in Hagberg 1988b indicate that, when a monosyllabic word is followed by a stressed syllable, the pitch of the monosyllabic word will be lower than that of the following stressed syllable. This is a phrase-level phenomenon (probably downdrift) which I do not discuss here.

(12)	ná'ikia	count (tran)	(13)	chiwéka	shelling (tran)
	hína'ikia	count (intr)		hichíweka	shelling (intr)
	híhina'ikia	always count		hihíchiweka	always shelling

In contrast, each of the forms in (7), (9), (11) and (13) bears stress on the second syllable. Notice that the prefixes are the same in all eight sets of forms.

The data in (6) through (13) are representative of the entire Mayo language in that stress falls on either the first or second syllable of every word. The distribution of coda consonants appears to have no bearing on stress placement; the stress pattern for a given stem remains constant even when the first syllable of the stem is 'closed', as in (6), (7) and (10).[7] Furthermore, a survey of some 1600 Mayo words listed in Collard and Collard 1962 indicates that the Mayo lexicon is roughly evenly divided between first and second syllable stress. There is no way to predict, either from the morphology or from the phonology, which of the two stress patterns a particular word will have, so one of the two patterns must somehow be marked in the lexicon.

The challenge for any theory of stress, then, is to account for Mayo's two stress patterns in a uniform manner. The autosegmental theory of stress, like many others such as H&V and Hayes 1991, provides only two kinds of devices for representing underlying stress contrasts. One of these is lexical accent and the other is lexical extrametricality.[8] Extrametricality, which was first proposed as a formal device in

[7]The distribution of stress is not so easily stated for words containing long vowels. This is discussed in section 5.2.

[8]Halle and Idsardi 1992 replace extrametricality with a complex set of edge-marking parameters that are able to produce the same effect.

Hayes 1979, is the exclusion of some peripheral element, typically either a syllable, mora or segment, from the domain of Stress Assignment. Extrametricality may be assigned by rule or it may be underlying, in which case it is called *lexical* extrametricality. In addition to the illustrations in the discussion that follows, numerous examples of the use of extrametricality may be found in the literature on metrical theory.[9]

Like extrametricality, accent may be either underlying or derived. Unlike extrametricality, however, accent is a diacritic whose function is to ensure that stress surfaces on the particular stress-bearing unit to which the accent is attached. Except where otherwise indicated, I follow H&V in representing accent in the same manner as stress, i.e., with an asterisk. Unlike H&V, however, I consider the stress asterisk to be an autosegment.

Returning to the Mayo stress pattern, the first question to be asked is, which is needed, lexical accent or lexical extrametricality? Before answering this question, however, a potential objection needs to be addressed. One might imagine an alternative approach which uses a pure diacritic instead of accent or extrametricality. Such an analysis would assume two word classes, e.g., class A and class B. Each of these word classes would have its own set of rules for stress assignment, so there would be no need for any lexical device other than some kind of diacritic to indicate which of the two classes a word belongs to. For

[9]See, for example, Inkelas 1989 as well as Archangeli's 1984-5 account of Yawelmani stress and Halle and Vergnaud's 1987b treatment of exceptional stress in Macedonian and Polish.

an example of this method of representing stress contrasts, see Tsay 1990.

Although such an approach would indeed afford an adequate account of Mayo's two stress patterns, it must be rejected for the following reason. Length occurs in both vowels and consonants in Mayo, and in most cases it is derived rather than underlying. Section 5.2 demonstrates that derived vowel length and derived consonant length are in near-complementary distribution with respect to stress. On the one hand, there is a correlation between the distribution of derived vowel length and the distribution of second syllable stress. On the other hand, there is a similar correlation between the distribution of derived consonant length and the distribution of first syllable stress. Under the 'pure diacritic' approach outlined above, these parallel correlations between stress class and lengthening class would be totally coincidental. In other words, the analysis would have to stipulate something like the following: 'Words of class A have first syllable stress and exhibit consonant gemination; words of class B have second syllable stress and exhibit vowel lengthening.' Clearly, any analysis which can relate a word's stress pattern to its lengthening pattern in a principled way is to be preferred (all other things being equal) to an analysis in which this relationship is entirely coincidental, as is the case in the aforementioned approach. In fact, section 5.2 argues for an analysis in which the relationship between stress and lengthening finds a principled explanation.

In light of the arguments to be presented in section 5.2, then, the 'pure diacritic' approach must be rejected. Consequently, there are only two remaining possible means of accounting for the Mayo stress contrast. One of these uses lexical accent and the other uses lexical extrametricality. In what follows I argue that the facts of Mayo stress require an analysis which utilizes lexical accent rather than lexical extrametricality. Furthermore, chapter 5 argues that Mayo's lexical accent is capable of floating and undergoes cyclic rules of linking and delinking, as was briefly discussed in section 1.2.3. Since these types of behavior are characteristic of autosegments and since I have already argued that stress is an autosegment, it would seem logical to use lexical accent to represent Mayo's stress contrast. On the other hand, there is no precedent for attributing autosegmental behavior to the device of extrametricality.

I first present the formal analysis of Mayo stress and illustrate how it works, and then the primary evidence for using lexical accent rather than lexical extrametricality is presented. Additional arguments for this choice are given in chapter 5 based on the facts of reduplication and vowel length alternations.

The analysis for which I argue is stated in (14).

(14) Mayo Stress Assignment:

(a) Build a single syllabic foot from left to right.

(b) Insert * in the foot and link from right to left.

For the moment, I assume that second syllable stress is unmarked in Mayo. That is, I assume that words with second syllable stress do not contain lexical accent or any other lexical device that might be used to generate exceptional stress.[10] The derivation of stress in such words is straightforward, as illustrated in (15).

```
(15) Input:               Build 1 Foot:         Insert & Link *:     Output:

                                                      *
                                                      |
      σ     σ   σ         (σ     σ)  σ          (σ     σ)  σ
     /|\   /|  /|         /|\   /|  /|          /|\   /|  /|
     p o n n a k e        p o n n a k e         p o n n a k e        ponnáke
```

When a prefix is added to an unaccented word, stress ends up on the second syllable of the prefixed form. This gives the impression that the rules of stress assignment apply to the entire word *after* prefixation has taken place, as illustrated in (16).

```
(16) Input:                           Build 1 Foot:

      σ   σ     σ   σ                 (σ   σ)    σ   σ
     /|  /|\   /|  /|                 /|  /|\   /|  /|
     h i-p o n n a k e                h i p o n n a k e

     Insert & Link *:                 Output:

           *
           |
     (σ   σ)    σ   σ
     /|  /|\   /|  /|
     h i p o n n a k e                hipónnake
```

[10]Henceforth, I refer to words with lexical accent and words which lack lexical accent as *accented* and *unaccented*, respectively.

Of course, this does not necessarily prove that the rules of stress assignment apply only after prefixation has taken place. Based only on the data considered thus far, it is equally possible that previously created foot structure is deleted at the beginning of each cycle, and that foot-building reapplies each time an affix is added.[11] In fact, chapter 5 argues that this is exactly what happens.

The derivation of stress in unaccented words is thus accounted for, but how about the stress pattern of accented words? Since stress in these words always surfaces on the first syllable, it appears that the two rules in (14) either don't apply at all or are neutralized by some other process. Chapter 5 presents a formal account of how first syllable stress is derived, but for now I wish to demonstrate only that first syllable stress is lexically marked with an accent and that second syllable stress is lexically unmarked.

Notice that there is no way to represent the contrast between first and second syllable stress with an accent that is underlyingly associated to a particular stress-bearing unit, as is done in H&V's analysis of a number of languages. If lexical accent were assumed to be underlyingly associated to a particular stress-bearing unit in Mayo, then one would be forced to conclude that one of the following is true: Either each of the twelve forms in (6), (8), (10) and (12) has lexical accent on the first syllable, or else each of the twelve forms in (7), (9), (11) and (13) has lexical accent on the second syllable. But the

[11]The separation of constituency and stress raises the question of whether * Insertion is cyclic or non-cyclic. Chapter 5 argues for the latter.

latter cannot be true, for there would then be no way to explain why lexical accent occurs only on the second syllable and never on any other syllable.

Furthermore, if it were true that each of the twelve forms in (6), (8), (10) and (12) had lexical accent on the first syllable, then the indefinite object prefix *[hi-]* would have to have lexical accent, so eight out of the twelve forms in (7), (9), (11) and (13) (repeated below as (17) through (20)) should exhibit first syllable stress as well. In fact all of these forms have regular second syllable stress, which indicates that the prefix *[hi-]* does *not* have underlying accent.

(17)	ponnáke	
	hipónnake	*híponnake
	hihíponnake	*híhiponnake
(18)	ba'áte	
	hibá'ate	*híba'ate
	hihíba'ate	*híhiba'ate
(19)	wiséka	
	hiwíseka	*híwiseka
	hihíwiseka	*híhiwiseka
(20)	chiwéka	
	hichíweka	*híchiweka
	hihíchiweka	*híhichiweka

Thus, the assumption that lexical accent in Mayo is always associated underlyingly with a particular stress-bearing unit leads to a paradox. In order to maintain this segmental approach to lexical accent, it would be necessary to postulate an *ad hoc* stress movement rule such as 'shift stress leftward following prefixation if the stem is accented but not if it is unaccented.' In contrast, only standard phonological rules

are required under the autosegmental approach. The basic idea is that a lexical accent begins each morphological cycle as a floating autosegment (having delinked at the end of the preceding cycle) and links to the leftmost stress-bearing unit sometime after prefixation has taken place.

This analysis of Mayo's lexical accent is reminiscent of the tonal analyis of Tiv that was reviewed in section 2.2.2. Recall that a segmental approach to tone in Tiv was not able to account for the behavior of verbs inflected with the General Past. In contrast, by representing the General Past as a prefix consisting of nothing more than a floating L-tone, Pulleyblank 1986 was able to incorporate the behavior of the General Past morpheme into the phonology of Tiv without appealing to any *ad hoc* devices. The only relevant difference between Mayo and Tiv is that the latter has no delinking rule.

The details of the Mayo analysis are presented and motivated in chapter 5. The point to be made here is that lexical accent, if used in the analysis of Mayo stress, must be autosegmental; a segmental view of lexical accent is inconsistent with the data in (6) through (13).

Thus far, it has been assumed that exceptional stress is marked by lexical accent, but recall that lexical extrametricality is also a possible means of accounting for exceptional stress (as well as tonal phenomena).[12] In what follows, however, it is argued that lexical extrametricality cannot account for the facts of stress in Mayo. This

---

[12]The choice between lexical accent and lexical extrametricality is not necessarily arbitrary. For example, Hammond 1988b argues that exceptional stress in Polish can be accounted for with the former but not with the latter.

leaves lexical accent as the only viable means of deriving the observed contrast between first and second syllable stress. Hence, given the earlier argument that lexical accent cannot be utilized to account for second syllable stress, it must be the case that second syllable stress is lexically unmarked. The conclusion is that words with second syllable stress have right-stressed syllabic feet, as generated by the rules in (14).

If lexical extrametricality were in fact responsible for exceptional stress, then the forms in (7), (9), (11) and (13) would have to be lexically marked so as to render the first syllable extrametrical. A stress autosegment could then be linked from left to right directly to the metrical portion of the word.[13] This approach is illustrated in (21).

```
(21) Input:                 Link Stress L to R:     Output:

                                     *
                                     |
     <σ>    σ   σ           <σ>    σ   σ
     /|\   /|  /|           /|\   /|  /|
     p o n n a k e          p o n n a k e           ponnáke
```

There are two problems with this analysis. First, the Peripherality Condition (Hayes 1981) requires that the lexical extrametricality in (21) disappear following prefixation because the extrametrical portion of the word is no longer peripheral. This is illustrated below.

---

[13]The same effect could be achieved by constructing a syllabic foot from left to right and linking a stress autosegment to the left edge of the foot.

(22) Input:

```
 <σ>     σ   σ
 /|\    /|  /|
p o n n a k e
```

Prefixation:

```
 σ  <σ>     σ   σ
/|  /|\    /|  /|
h i-p o n n a k e
```

Loss of EM:

```
 σ   σ      σ   σ
/|  /|\    /|  /|
h i p o n n a k e
```

Link Stress L to R:

```
 *
 |
 σ   σ      σ   σ
/|  /|\    /|  /|
h i p o n n a k e
```

Output:

**híponnake* (Should be *hipónnake)*

Thus, underlying extrametricality is not able to account for the perseverance of second syllable stress under prefixation.

In what follows I provide an additional argument against the representation in (21), concluding that lexical accent, but not lexical extrametricality, is needed in order to adequately describe Mayo stress. Consider the representative loan words from Spanish in (23) through (28). In each case the Mayo form has second syllable stress even though the Spanish form has first syllable stress in some cases and second syllable stress in others. This pattern generally holds for loan words: With very few exceptions, words end up with second syllable stress when they are borrowed into Mayo. I take this as evidence that second syllable stress is the unmarked case for Mayo words.

	Spanish:	Mayo:	English:
(23)	váca(s)	wakás	*cow*
(24)	bócha	bochá	*shoe*
(25)	cábra	kabára	*sheep*
(26)	péso	pesó	*peso (money)*
(27)	domíngo	lomínko	*Sunday*
(28)	Diós	lióh	*God*

This general characteristic of loan words constitutes an argument against the possibility that words with second syllable stress are marked underlyingly for extrametricality: If lexical extrametricality were used to obtain second syllable stress, then first syllable stress would have to be the unmarked case. However, Spanish words which have first syllable stress often acquire second syllable stress when they are borrowed into Mayo. Under the lexical extrametricality analysis, this would mean that each of these words acquires lexical extrametricality when it is borrowed into Mayo. It would be difficult if not impossible to explain why and how nearly all words could acquire marked stress when borrowed into Mayo, regardless of the stress pattern of the word in the source language. Why wouldn't the stress simply remain unmarked in at least some of the borrowings? I take this as evidence that first syllable stress is in fact the marked case rather than the unmarked one in Mayo, and I conclude that lexical accent, but not lexical extrametricality, must be used in order to account for exceptional first syllable stress.

Since lexical extrametricality cannot be used in the derivation of second syllable stress, this stress pattern has to be derived from right-stressed syllabic feet, as in (14). Notice that this is one of the surface foot types predicted by the autosegmental theory of stress (see section 2.3.2.2), and yet Hayes 1991 claims that such feet do not

exist.[14] Thus, the Mayo data provide one argument in favor of the autosegmental theory of stress and against the theory of Hayes 1991.

In summary, the perseverance of Mayo's two different stress patterns under prefixation may be accounted for if it is assumed that words with first syllable stress have a lexical accent which is capable of floating, and that this accent links by rule from left to right following prefixation. Furthermore, since it is not possible to account for the Mayo data using lexical extrametricality, second syllable stress must be derived from right-stressed syllabic feet. Hayes 1991 claims that this foot type does not exist, but its existence is predicted by the autosegmental theory of stress.

Thus far, I have instantiated the two logically possible surface combinations of a stress autosegment with a syllabic foot. Warao was cited as having left-stressed syllabic feet, and certain Mayo words (those with second syllable stress) were shown to exhibit right-stressed syllabic feet. Next, I illustrate the two corresponding types of moraic feet.

---

[14]Hayes actually allows for the existence of such feet on the surface, but he claims that they occur only in languages which do not have a syllable weight distinction at the level of the derivation where stress applies. He makes this claim in order to argue that right-headed syllabic feet actually constitute iambic (i.e., asymmetric) feet. He argues that, if a language's grammar calls for iambic feet but has no syllable weight distinction available to it, then its [underlyingly] iambic feet will be indistinguishable from syllabic feet. This explanation does not work for Mayo, however, for Mayo *does* have a syllable weight contrast which shows up prior to foot-building and interacts with the stress autosegment even though foot-building is not sensitive to syllable weight. This is discussed in section 5.2.

3.1.2. Moraic Feet.

Moraic feet are built from two moras which may be either tautosyllabic or heterosyllabic. The construction of moraic feet is constrained by the independent principle of Syllable Integrity. As section 1.2.2 explained, Syllable Integrity prohibits the placement of a higher-level prosodic boundary between two tautosyllabic moras. In the case of moraic feet, this means that both moras of a bimoraic syllable have to belong to the same foot. The significance of this point is made apparent in some of the derivations that follow.

This section discusses Cairene Arabic and Turkish as examples of languages with left-stressed and right-stressed moraic feet, respectively. I consider first the stress pattern of Cairene Arabic.

3.1.2.1. Cairene Arabic Stress.

Recall from section 1.2.2 that Cairene Arabic stress falls on the last syllable only if it is superheavy. Otherwise, stress is on the penult if it is heavy. If neither of these conditions holds, then the stress pattern is determined by counting the number of syllables following the rightmost heavy syllable, if there is one, or else from the beginning of the word. An even count (where zero is considered even) produces penultimate stress and an odd count results in antepenultimate stress.

My analysis of Cairene Arabic stress consists of two steps. First, moraic feet are built iteratively from left to right. Second, a

stress autosegment * is inserted into each foot and links from left to right.[15] These steps are formalized in (29) and illustrated in (30).

(29) <u>Cairene Arabic Stress</u>:

(a) Build moraic feet iteratively from left to right.

(b) Insert * into each foot and link from left to right.

(30)

```
Input:          Build Feet:        Insert & Link *:     Output:

                                    *     *
                                    |     |
 μ μ μ μ        (μ  μ) (μ  μ)      (μ  μ) (μ  μ)
 | | | |         |  |   |  |        |  |   |  |
katabitu        kata bitu          kata bitu            kàtabítu
```

Notice that foot-building has to be iterative in order to account for the fact that stress placement is determined by the overall mora count proceeding rightward from the rightmost heavy syllable or, in words which lack heavy syllables, from the beginning of the word.

Now consider what happens when a word contains three short syllables, as in (31). Since foot-building occurs from left to right, the first two moras are incorporated into a foot, but the third mora remains unfooted because it lacks a partner.

---

[15]See footnote 6 in section 2.1.1 regarding the question as to whether stress surfaces in all feet or only on the final one. Since my analysis generates stresses in the same places as Hayes', I assume that non-final feet have secondary stress rather than no stress. If they were in fact stressless, then I would either remove the excess stresses via a deletion rule or else assign stress only to the rightmost foot.

(31) Input: Build Feet: Insert & Link *: Output:

```
                                  *
                                  |
 μ μ μ       (μ μ)  μ           (μ μ)  μ
 | | |        | |   |            | |   |
 buxala       buxa  la           buxa  la            búxala
```

As was pointed out in chapter 1's discussion of Cairene Arabic, Syllable Integrity plays a role in determining the stress pattern of words that contain a heavy syllable. This is illustrated in (32). Notice that the first mora cannot be incorporated into a foot with the following mora in this case, because to do so would create a syllable-internal foot boundary, i.e., a violation of Syllable Integrity. Consequently, the first mora remains unfooted and stress ends up on the heavy syllable.[16]

(32) Input: Build Feet: Insert & Link *: Output:

```
                                       *
                                       |
 μ μμ μ        μ (μμ) μ             μ (μμ) μ
 | || |        |  ||  |             |  ||  |
 qamalti       qa mal ti            qa mal ti          qamálti
```

However, (29) predicts the wrong stress pattern for words which end in a heavy syllable, such as *shàjarátun*, because the two moras of a final heavy syllable should be incorporated into a foot, as demonstrated in (33).

---

[16]See McCarthy and Prince 1990 (page 253, footnote 22) for a similar example of the interaction of Syllable Integrity with the construction of bimoraic feet.

(33) <u>Input</u>:	<u>Build Feet</u>:	<u>Insert & Link *</u>:	<u>Output</u>:
		* *	
		| |	
μ μ μ μμ	(μ μ) μ (μμ)	.(μ μ) μ (μμ)	
| | | ||	| | | ||	| | | ||	
shajaratun	shaja ra tun	shaja ra tun	**shàjaratún*

In fact, stress never occurs on a final heavy syllable. The only way to derive this fact is to somehow ensure that final heavy syllables are treated as light syllables. In order to achieve this effect, I follow McCarthy and Prince 1990 in assuming that a word-final mora is extrametrical. Accordingly, the derivation of *shàjarátun* proceeds as in (34), where the final syllable is treated as light.

(34) <u>Input</u>:	<u>Build Feet</u>:	<u>Insert & Link *</u>:
		* *
		| |
μ μ μ μ<μ>	(μ μ) (μ μ) <μ>	(μ μ) (μ μ) <μ>
| | | | |	| | | | |	| | | | |
shajaratu n	shaja ratu n	shaja ratu n

<u>Output</u>:

shàjarátun

Notice that there is no violation of Syllable Integrity in (34) because the final syllable contains only a single element that is visible. Likewise, the foot-building rule treats a final long vowel as monomoraic; this is illustrated in the following derivation of *'àdwiyatúhumaa*.

```
(35) Input:                   Build Feet:                  Insert & Link *:

                                                           *     *     *
                                                           |     |     |
     μμ μ  μ  μ  μ  μ<μ>       (μμ) (μ  μ) (μ  μ) μ<μ>     (μμ) (μ  μ) (μ  μ) μ<μ>
     || |  |  |  |  |/          ||   |  |   |  |  |/        ||   |  |   |  |  |/
    'adwiyatuhuma              'ad wiya tuhuma             'ad wiya tuhuma
```

Output:

'àdwìyatúhumaa

I assume that extrametricality is prevented from applying to the lone mora of a monomoraic syllable by the universal requirement that every syllable have at least one mora, as claimed in Hyman 1985 and Hayes 1989. If this were not the case, then the application of (29) would incorrectly produce **katábitu* and **'àdwiyátuhu* instead of *kàtabítu* and *'àdwìyatúhu*.

Although extrametricality prevents stress from occurring on a final heavy syllable, it cannot prevent foot-building from occurring in a superheavy syllable. Consequently, a superheavy syllable is always stressed, as illustrated in (36).

```
(36) Input:          Build Feet:          Insert & Link *:         Output:

                                               *
                                               |
      μ  μ  μ<μ>      μ  (μ  μ)<μ>         μ  (μ  μ)<μ>
      |  |  |  |      |   |  |   |         |   |  |   |
     kata b  t       kat  a  b   t        kat  a  b   t           katábt
```

In summary, the autosegmental analysis of Cairene Arabic stress consists of two steps. First, moraic feet are built iteratively from left to right. Syllable Integrity prevents foot boundaries from occurring syllable-internally, resulting in the fact that primary stress is

determined by the location of the rightmost heavy syllable. Second, a stress autosegment is inserted into each foot and links from left to right. Following McCarthy and Prince 1990, I assume that a word-final mora is extrametrical.

Notice that the outputs of Hayes' derivations in section 1.2.2 are notationally equivalent to mine. The only significant difference (with regard to metrical theory) between his analysis and mine is that I build headless feet and assign stresses to them in a subsequent rule. This separation of foot structure and stress, which is foundational to the autosegmental theory of stress that I am proposing, is not actually required by the Cairene Arabic data, but the next two chapters demonstrate that it is is absolutely required by the data of Yidin^y, Mayo and Tagalog.

Next, the various stress patterns of Turkish are examined in detail. It is argued that one of these patterns instantiates the right-stressed moraic foot, an entity which is predicted by the autosegmental theory of stress but explicitly prohibited by Hayes' theory. It is also argued that the analyses of Turkish stress proposed by Kaisse 1985, Hammond 1986, Halle and Vergnaud 1987b and Hayes 1991 all resort to *ad hoc* devices, whereas the autosegmental analysis uses only independently motivated elements of phonological theory.

3.1.2.2. Turkish Stress.

This section proposes an autosegmental analysis of Turkish stress and contrasts it with the analyses proposed in Kaisse 1985, Hammond

1986, Halle and Vergnaud 1987b and Hayes 1991. The autosegmental analysis of Turkish stress is significant in two ways. First, Turkish place names and loan words exhibit right-stressed moraic feet, the existence of which is predicted by the autosegmental theory of stress but disallowed by Hayes' theory. Second, the separation of constituency and stress makes it possible to account for two different patterns of exceptional stress with a single footing rule, attributing the difference between the two stress patterns to a difference in underlying representations. In contrast, the other analyses of Turkish stress invoke unnecessary enrichments of metrical theory.

The autosegmental analysis is presented in section 3.1.2.2.1; the other analyses are discussed in 3.1.2.2.2.

3.1.2.2.1. An Autosegmental Analysis of Turkish Stress.

Most Turkish words have only one stress, which normally occurs on the ultima (Underhill 1976, Sezer 1983, Kaisse 1985, Hammond 1986, Hayes 1991). Examples follow:

(37) Turkish Final Stress (Underhill 1976, Kaisse 1985, Hammond 1986):

odá	*room*	tanɨ́	*know*
odalár	*rooms*	tanɨdɨ́k	*acquaintance*

Under the autosegmental theory of stress, the simplest way to account for this pattern is to assign a stress autosegment directly to the word rather than to a foot, as stated in (38):

(38) Turkish Stress Assignment: Insert * in the word and link from right to left.

The application of (38) is illustrated below:

(39) Input:	Insert * in Word:	Link:	Output:
	*	*	
		|	
μ μ	μ μ	μ μ	
| |	| |	| |	
o d a	o d a	o d a	*odá*

Underhill 1976 points out that all words, even polymorphemic ones, have only one stress.[17] I assume, therefore, that (38) is a non-cyclic rule, i.e., that it applies only once near the end of the derivation.

While (38) accounts for the stress pattern of most words, Turkish has three classes of exceptional stress. For convenience I refer to these as *place names*, the suffix *-en* and *compounds;* each is discussed in turn below.

The first class of exeptionally stressed words actually consists not only of place names, which are derived in some cases from Turkish words and in other cases from other languages, but also of loan words from a variety of source languages. Sezer 1983 was the first to note that stress in these words is rule-governed. The generalization is as follows, where both vowel length and codas count as heavy:

---

[17]However, Kaisse 1985 claims that suffixed place names and loan words exhibit secondary stress. This is discussed below.

(40) Exceptional Stress in Loan Words and Place Names (Sezer 1983):

(a) Words with a heavy penult are stressed on the penult.

(b) Words with a light penult and a light antepenult are stressed on the penult.

(c) Words with a light penult and a heavy antepenult are stressed on the antepenult.

Following are examples of each of the types in (40), taken from Sezer 1983:

(41) (a) Heavy Penult: Penultimate Stress:

lokánta	*restaurant*
Vasíngton	*Washington*
Antálya	*(city name)*
Istánbul	*(city name)*
katakúlli	*cheating*
samuélson	*Samuelson*
Montazú:ma	*Montezuma*
Ayzɨnhó:ver	*Eisenhower*

(b) Light Penult, Light Antepenult: Penultimate Stress:

Kenédi	*Kennedy*
Pitolémi	*Ptolemy*
tornavída	*screwdriver*
Papadopúlos	*Papadópoulos*
Indiyanapólis	*Indianapolis*

(c) Light Penult, Heavy Antepenult: Antepenultimate Stress:

ánkara	*(city name)*
şamándɨra	*buoy*

In order to account for the stress pattern of the above class of exceptionally stressed words, I propose that they undergo the following two cyclic lexical rules (plus the insertion and linking of a morphemic stress, to be discussed below): First, a word-final syllable is marked extrametrical, and then a single (stressless) moraic foot is constructed

from right to left. Although this foot is not referred to in the rule of regular stress assignment (38), it in fact plays a role in two types of exceptional stress. The foot formation process is summarized below.

(42) Cyclic Foot Construction (Exceptionally stressed words only):

(a) Mark the final syllable extrametrical.

(b) Build a single moraic foot from right to left.

An iambic foot would work just as well as a moraic foot for place names and loan words. However, only a moraic foot is able to account for the stress pattern of adverbials derived with *-en;* an iambic foot cannot be used. This is discussed below.

One might object to the above analysis on the grounds that feet are needed for exceptional stress assignment but not for regular stress assignment, so a language learner would have no evidence for a rule of foot-building until the exceptionally stressed words are encountered. However, Kaisse 1985 points out that exceptionally stressed place names are not a closed class of words. New place names are created as needed, and new loan words are borrowed quite frequently by the Turkish media. In every such instance, according to Kaisse, the stress pattern described in (40) is applied to the new word. Thus, while it is true that a language learner does not need to be aware of foot structure in order to learn the regular stress pattern, there has to be some productive algorithm for assigning exceptional stress that is totally independent of regular stress assignment. This situation is no different, in principle, from that of certain modern Arabic dialects, in which iambic

feet are utilized in certain morphological processes but moraic trochees (rather than iambs) are needed for stress assignment (McCarthy and Prince 1990). Thus, the productiveness of the exceptional stress pattern is consistent with the above analysis in which foot-building takes place only in exceptionally stressed words. Furthermore, the analyses of Kaisse 1985, Hammond 1986, Halle and Vergnaud 1987b and Hayes 1991 likewise assume that exceptionally stressed words do not undergo the regular rules of stress assignment but rather undergo some special set of rules.

The exceptional stress pattern of place names and loan words may now be accounted for by assuming that each of these words is derived via an autosegmental stress morpheme which is inserted into the foot and then links from right to left.[18,19] I call this the *Place Name* suffix. Since these words have only one stress, I assume that they do not undergo the regular rule of stress assignment.[20] The application of the above set of rules to place names and loan words is illustrated in the

---

[18]Since the direction of linking in regularly stressed words is from right to left, I assume that this is the default direction of linking in feet as well.

[19]For other examples of morphological processes whose domain is the foot, see McCarthy and Prince 1990.

[20]Kaisse 1985 claims that suffixed place names and loan words exhibit secondary stress on the final syllable, as in *ánkara-dàn* 'from Ankara'. Underhill 1976 states that stem stress is unaffected by suffixes in place names and loan words, but he makes no mention of secondary stress. If Kaisse is correct, then my analysis must be modified so as to allow regular stress assignment to apply to these words in addition to the rules of exceptional stress assignment.

following derivations. The simplest case occurs when both the penultimate and antepenultimate syllables are light:

```
(43) Input:              Extrametricality:        Build Foot:

     μ   μ   μ           μ   μ                    (μ   μ)
     |   |   |           |   |                     |   |
   K e n e d i           K e n e<d i>             K e n e<d i>

     Place Name Suffix:[21]    Output:

             *
             |
        (μ   μ)
         |   |
       K e n e<d i>           Kenédi
```

When the penultimate syllable is heavy and the antepenultimate syllable is light, stress again falls on the penultimate syllable. This time, however, * is forced to dock to the left mora of the foot rather than to the right mora because of the Nucleus Constraint, stated in (44):[22]

(44) Nucleus Constraint: Stress is always realized on the nucleus of the syllable.

```
(45) Input:              Extrametricality:        Build Foot:

      μ   μ μ   μ         μ   μ μ                  μ   (μ μ)
      |   | |   |         |   | |                  |    | |
    l o k a n t a       l o k a n<t a>           l o k a n<t a>
```

---

[21]In this and subsequent derivations, *-Insertion and Linking are represented as a single step in order to conserve space. This is not intended to imply that they must occur simultaneously.

[22]McCawley 1968, Haraguchi 1977, Poser 1984 and Ishihara 1991 argue for a similar constraint in Japanese based on the distribution of accent in syllables with complex nuclei. I leave open the question of whether the Nucleus Constraint is a universal principle or a language-particular rule.

```
Place Name Suffix:      Nucleus Constraint:      Output:

      *                        *
      |                       /‡
   μ(μμ)                 μ    μ μ
   | ||                  |    | |
   lokan<ta>             l o k a n<t a>          lokánta
```

The above derivation applies the Nucleus Constraint as though it were a repair strategy only for the purpose of expositional clarity. Formally, the stress autosegment is blocked from linking to a syllable non-nucleus.

In the derivations of *Kenédi* and *lokánta*, it would have been simpler to assign stress via the same rule that is used to derive regular stress, i.e., by assigning * to the word from right to left, without ever building a foot; exceptional penultimate stress could still be derived by assuming that words such as *Kenédi* and *lokánta* have lexical extrametricality. However, there is no way to derive antepenultimate stress without first building a foot. This is illustrated in (46), where the final metrical mora has to be 'skipped' by the footing rule in order to avoid violating the principle of Syllable Integrity:

```
(46) Input:             Extrametricality:        Build Foot:

     μ μ   μ   μ        μ μ   μ   μ              (μ μ)  μ   μ
     | |   |   |        | |   |   |               | |   |   |
     a n k a r a        a n k a<r a>              a n k a<r a>

     Place Name Suffix:   Nucleus Constraint:    Output:

         *                   *
         |                  /‡
      (μ μ)  μ   μ       (μ μ)  μ   μ
       | |   |   |        | |   |   |
       a n k a<r a>       a n k a<r a>           ánkara
```

Notice that, if the domain of *-Insertion were the word rather than the foot, there would be no way to derive antepenultimate stress in words such as *ánkara*. Hence, the stress pattern of these words provides evidence for the existence of foot structure in a stress system which otherwise would not need feet.

Thus far, I have discussed only the first class of exceptional stress, which consists of place names and loan words. The second class of exceptional stress is found in words which contain the suffix *-en*. In what follows it is argued that words derived with *-en* undergo the same foot-building process as that of place names and loans, but that stress links to opposite edges of the foot in these two classes of exceptional stress. Sezer 1983 describes the stress pattern of *-en* derivatives as follows:[23]

(47) "In adverbials derived with *-en*, primary stress is on the penult if it is strong. If the penult is not strong, then primary stress is on the antepenult." (page 63)

The following examples are from Sezer 1983:

(48) Heavy Penult in Inflected Form:

iktisát	*economics*	iktisá:den	*economically*
istinát	*support*	istiná:den	*based on...*
kazá:	*accident*	kazá:en	*accidentally*
esás	*basic*	esá:sen	*basically*

[23]Sezer's term 'strong' has the same meaning as 'heavy'.

(49) <u>Light Penult in Inflected Form</u>:

mũnhasír	*special to*	mũnhásiran[24]	*specially*
mũsterék	*mutual*	mũstéreken	*mutually*
tekeffűl	*becoming surety*	tekéffũlen	*by surety*
muvakkát	*temporary*	muvákkaten	*temporarily*
nisbét	*ratio*	nísbeten	*proportionally*
haki:kát	*truth*	hakí:katen	*in truth*

The contrast between the above class of exceptional stress and the one discussed earlier may be summarized as follows. Whereas stress placement in place names is sensitive to the weight of both the penult and the antepenult, stress placement in words derived with *-en* is sensitive only to the weight of the penult. This means that it is not possible to account for both stress types with a single set of rules. Under a theory which treats feet as inherently headed, two different sets of foot-building rules are required; examples are discussed in the next section. Under a theory which separates constituency and stress, however, only one set of foot-building rules is needed. The contrast may then be represented by assigning a stress autosegment to the foot in different ways; this is explained below.

In order to account for the above data in a manner that is consistent with the analysis that was proposed for exceptional stress in place names and loan words, I assume that *-en* suffixation makes use of the same moraic foot that is generated in the latter. Specifically, I propose that *-en* suffixation proceeds as follows. First, *-en* is suffixed to the stem. Next, the final syllable is rendered extrametrical and a

---

[24]The alternation in vowel quality in this form (*-an* rather than *-en*) is due to the familiar rule of back harmony and is irrelevant to the facts of stress.

moraic foot is constructed from right to left, just as is done for place names and loan words. Finally, a stress autosegment is inserted into the foot and links from left to right. Since this is not the default direction of linking, I assume that *-en* is marked in the lexicon so as to trigger left to right linking of stress. This results in the following derivations:

```
(50) Input:               Add -en:                 Extrametricality:

     μ μ   μ   μ μ μ      μ μ   μ   μ μ  μ μ       μ μ   μ   μ μ
     | |   |   |/  |      | |   |   |/   | |       | |   |   |/
     i k t i s a   d      i k t i s a  d-e n       i k t i s a <d e n>

     Build Foot             Insert/Link * in Σ:     Output:

                                    *
                                    |
     μ μ   μ  (μ μ)         μ μ   μ  (μ μ)
     | |   |   |/           | |   |   |/
     i k t i s a <d e n>    i k t i s a <d e n>     iktisá:den

(51) Input:               Add -en:                 Extrametricality:

       μ μ   μ   μ μ        μ μ   μ   μ μ μ μ        μ μ   μ   μ
       | |   |   | |        | |   |   | | | |        | |   |   |
     m ü n h a s i r      m ü n h a s i r-a n      m ü n h a s i<r a n>

     Build Foot             Insert/Link * in Σ:     Output:

                                  *
                                  |
       μ μ  (μ   μ)           μ μ  (μ   μ)
       | |   |   |            | |   |   |
     m ü n h a s i<r a n>   m ü n h a s i<r a n>    münhásiran
```

The innovation of the analysis outlined above is that it utilizes a single foot-building process to account for both classes of exceptional stress, attributing the contrast between these two classes to a

difference in the direction of autosegmental linking rather than to different kinds of primitive feet. That is, a single parametric difference between these two word classes applies to a single primitive foot to produce contrastive foot types on the surface: *-en* affixation results in a *left*-stressed moraic foot whereas place name suffixation results in a *right*-stressed moraic foot. The latter is predicted by my theory but disallowed by Hayes' theory. Furthermore, as was argued above, there is no way to derive the stress patterns of these two word classes using a single type of inherently headed foot. The separation of stress and foot structure, on the other hand, allows both word classes to utilize the same foot. This approach is possible only if feet are assumed to be inherently headless.

Given that feet really are inherently headless, as I claim, we should expect to find other languages which, like Turkish, can link a stress autosegment to either member of a foot. Indeed, chapter 4 argues that Yidin^y builds feet which can later have stress linked to either member. The Uniform Linking Constraint is not violated in either of these languages, for there is only one direction of linking per word.

One question remains, however, regarding the above analysis. Given that both classes of exceptional stress are derived using a moraic foot, how is the difference between the place name suffix and the *-en* suffix to be represented? That is, how can one of these two morphemes be marked in underlying representation so as to ensure that the stress autosegment will link from right to left in place names and from left to right in adverbials derived with *-en*? Notice that there is nothing in

autosegmental theory itself that would prohibit an autosegment from linking in two different directions for two different morphemes.[25] Nevertheless, this seems to be a marked situation, and some kind of formal account is needed. I leave this as a question for future research.

To summarize thus far, the grammar of Turkish uses the following rules to assign exceptional stress: final syllable extrametricality, the right to left construction of a single bimoraic foot, and the right to left or left to right insertion/linking of * to the foot. As stated earlier, I assume that right to left is the default direction of linking, and that a rule applies idiosyncratically to adverbials derived with *-en*, overruling this default direction. Furthermore, since there appears to be no evidence for the presence of feet in regularly stressed words, I assume that foot construction applies only in exceptionally stressed words.

Foot construction might seem altogether unnecessary were it not for the occurrence of words with antepenultimate stress. Since antepenultimate stress occurs only in certain morphological contexts (and then only when the right phonological conditions are also met), it is attributed to a morphologically-generated stress autosegment whose domain of insertion and linking is the foot rather than the word.

It was stated earlier that there are three types of exceptional stress in Turkish. So far, two of these have been discussed; I now turn to the third type of exceptional stress, which occurs in compounds as

---

[25]Indeed, Archangeli and Pulleyblank (in press) propose this in their analysis of Yoruba tone, as discussed in section 2.2.2.

well as in words which Sezer 1983 calls *emphatic adjectives*. The derivation of these forms is straightforward under the autosegmental theory of stress; they are included here only for the sake of completeness. I first discuss compounds.

Underhill 1976 states that "compounds in Turkish are accented on the last syllable of the first member. Thus búgün 'today', a compound of bu 'this' and gün 'day', is accented on bu; karádeniz 'Black Sea' is accented on the last syllable of kara" (page 117). This observation may be accounted for under a theory of compounding that was first proposed in Inkelas 1989 and further developed in Ishihara 1991. The basic idea is that a compound is represented as a sequence of two prosodic domains corresponding to a single morphological domain. The application of a certain set of phonological rules, which may or may not be unique to compounding, is triggered by the creation of such a representation, just as normal morphological concatenation triggers the application of a particular set of lexical rules. In the case of Turkish compounding, I assume that the following rule applies. Following Inkelas 1989 and Ishihara 1991, $[\quad]_P$ represents a prosodic domain and $[\quad]_M$ represents a morphological domain.

(52) Compound Stress Insertion:

$$\begin{array}{ccc} [\quad]_P[\quad]_P & & [\,*\,]_P[\quad]_P \\ & \longrightarrow & \\ [\qquad\quad]_M & & [\qquad\quad]_M \end{array}$$

The above rule is identical to Ishihara's 1991 rule of High Tone Insertion for Japanese compounds (see section 2.2.3) except for the fact that

the inserted autosegment in Turkish is a stress rather than a high tone. As mentioned earlier, from the regular stress pattern of non-compounds it may be inferred that the default direction of linking is right to left. Hence, the direction of linking does not need to be specified in (52).

The application of Compound Stress Insertion is illustrated below.

(53) <u>Input</u>: <u>Compound Stress</u>: <u>Output</u>:

$$\begin{array}{ccccccccc} & & & & & & & & \\ & & & & & & & & \\ & \mu & & \mu & & \mu & & \mu & \mu \\ & | & & | & & | & & | & | \\ [k & a & r & a]_p & [d & e & n & i & z]_p \end{array} \qquad \begin{array}{ccccccccc} & & & * & & & & & \\ & & & | & & & & & \\ & \mu & & \mu & & \mu & & \mu & \mu \\ & | & & | & & | & & | & | \\ [k & a & r & a]_p & [d & e & n & i & z]_p \end{array} \qquad \textit{karádeniz}$$

Since regular final stress is unattested in compounds, I assume that regular stress assignment either is somehow blocked from applying or else applies but is subsequently neutralized via a delinking rule.[26]

The above analysis of stress in compounds is able to account for the slightly more complex set of forms which Sezer 1983 refers to as *emphatic adjectives*. Basically, these are formed via a morphological process which copies a monomoraic syllable from the left edge of the stem and adds a voiceless bilabial obstruent.[27] The resulting sequence is

---

[26]If Kaisse's 1985 aforementioned claim about secondary stress in suffixed place names and loan words is correct, then the latter must be considered to comprise two morphological domains at the time of stress assignment. Otherwise, they would be expected to have only one stress, as in compounds.

[27]I am ignoring the nasalization in *bómbok* and the p/s alternation in *tóstoparlak* because these are not relevant to the analysis of stress.

then prefixed to the stem, and stress falls on the prefix. This is exemplified in (54).

(54)	incé	*thin*	ípince	*very thin*
	bók	*ordure*	bómbok	*utterly useless*
	kırmızí	*red*	kípkırmızı	*bright red*
	toparlák	*round*	tóstoparlak	*perfectly round*

Emphatic adjectives may be derived as follows. First, the emphatic morpheme is represented as a clitic with the underlying form *μp-*, where *μ* is an empty monomoraic syllable which copies the first onset-vowel sequence of the following word, and *p* is a voiceless bilabial obstruent.[28] The initial stress of an emphatic adjective is derived by assuming that the emphatic morpheme is compounded with the following word. Since the emphatic morpheme is the first member of the compound, it alone gets stressed by the rule of Compound Stress Insertion (52); the 'stem' remains stressless. This is illustrated below.

(55) <u>Input</u>:

```
μ μ   μ
| |   |
[i n c e]P
```

<u>Emphatic Prefix</u>:

```
μ        μ μ   μ
         | |   |
[ p ]P [i n c e]P
```

<u>Copy Melody</u>:

```
μ        μ μ   μ
|        | |   |
[i p]P [i n c e]P
```

<u>Compound Stress</u>:

```
*
|
μ        μ μ   μ
|        | |   |
[i p]P [i n c e]P
```

<u>Output</u>:

ípince

[28]In order for the melody of the stem to be accessible for copying, I assume that the [p] of the clitic is on a different plane from the melody of the stem.

In summary, I account for regular final stress in Turkish via the insertion of a stress autosegment in the word followed by right to left linking. The three classes of exceptional stress do not undergo this rule, but rather are accounted for as follows. First, place names and adverbials derived with *-en* undergo a rule of final syllable extrametricality followed by the construction of a single bimoraic foot from right to left. Both of these exceptional classes assign stress to the foot, but one links it in the default right to left direction and the other links it in the opposite direction. Presumably, the latter must be underlyingly marked for directionality of linking. Compounds, on the other hand, undergo only the rule of Compound Stress Insertion (52). By treating emphatic adjectives as compounds, their stress pattern is accounted for without the need to posit any additional rules.

Next, I review the analyses of Turkish stress that are proposed in Kaisse 1985, Hammond 1986, Halle and Vergnaud 1987b and Hayes 1991. It is concluded that each of these entails theoretical complications that are avoided in the above analysis.

3.1.2.2.2. Other Analyses of Turkish Stress.

This section reviews four different analyses of Turkish stress and examines the theoretical merits of each one. The first is found in Kaisse 1985, the second in Hammond 1986, the third in Halle and Vergnaud 1987b and the fourth in Hayes 1991. The first two propose foot types which appear to be otherwise unnecessary. Similarly, the proposals of H&V and Hayes are argued to ascribe excessive power to metrical theory.

Following the theory of Hayes 1981, Kaisse 1985 proposes the following analysis of Turkish stress.

(56) Kaisse's 1985 Analysis:

Foot Formation for Place Names & Loan Words: Mark final syllables extrametrical. At the right edge of the word, form a left-dominant, quantity-sensitive, binary foot. Dominant nodes must branch.

Foot Formation for Words Containing -en: Mark final syllables extrametrical. At the right edge of the word, form a left-dominant, quantity-sensitive, binary foot.

Word Stress: At the right edge of the word, form an unbounded, right-branching word tree. Label left nodes strong iff they branch.[29]

The above proposal results in the following derivations for place names and loan words:

```
(57) Input:       Extrametricality:     Foot Formation:     Word Stress:

                                                             *
                                         *                  (*)
     *  * *       *  *                  (*   *)             (*   *)
     ankara       anka<ra>               anka<ra>            anka<ra>

     Output:

     ánkara
```

```
(58) Input:       Extrametricality:     Foot Formation:     Word Stress:

                                                              *
                                          *                  (*)
      * *   *      * *                   *(*)               *(*)
     vasington    vasing<ton>           vasing<ton>         vasing<ton>
```

[29]Kaisse labels left nodes strong iff they branch in order to account for secondary stress in suffixed place names such as *ánkara-dàn* 'from Ankara'.

Output:

vasíngton

Because of the requirement that dominant nodes must branch, a word with only light syllables fails to undergo Foot Formation. Word Stress still applies to the unfooted syllables, however, producing penultimate stress:

```
(59) Input:       Extrametricality:   Foot Formation:   Word Stress:

                                                           (*)
                                                         (* *)
     kenedi       kene<di>               N/A             kene<di>
```

Output:

kenédi

For Words containing *-en*, the derivations are as follows. When either the penultimate or the antepenultimate syllable is heavy, Foot Formation produces the same result as it does for place names:

```
(60) Input:       Extrametricality:   Foot Formation:   Word Stress:

                                                           *
                                         *                (*)
     * *  *       * *                   *(*)              *(*)
     esa:sen      esa:<sen>             esa:<sen>         esa:<sen>
```

Output:

esá:sen

```
(61) Input:        Extrametricality:   Foot Formation:   Word Stress:

                                                            *
                                           *               (*)
     * *  * *     * *  *                 *(*   *)         *(*   *)
     tekeffulen   tekeffu<len>           tekeffu<len>     tekeffu<len>
```

<u>Output</u>:

tekéffulen

If, however, both the penultimate and antepenultimate syllables are light, then stress occurs on the antepenultimate syllable instead of the penultimate syllable because the Foot Formation rule that applies to these forms does not require dominant nodes to branch:

```
(62) Input:        Extrametricality:   Foot Formation:   Word Stress:

                                                            *
                                           *               (*)
     *  * * *      *  * *                *  (* *)         *  (* *)
     mũnhasiran    mũnhasi<ran>          mũnhasi<ran>     mũnhasi<ran>
```

<u>Output</u>:

mũnhásiran

Hammond 1986 points out that the obligatory branching foot which Kaisse uses in her analysis of Turkish place names does not appear to be needed in other languages. In its place he proposes the *Revised Obligatory Branching* (ROB) foot. Hammond defines the ROB foot as one in which the head must dominate a heavy syllable and nonheads may dominate either a heavy or a light syllable. Hammond's analysis of Turkish stress is summarized below.

(63) <u>Hammond's 1986 Analysis of Exceptional Stress</u>:

(a) Make the final syllable extrametrical.

(b) Build a maximally binary right-headed ROB foot on the right edge.

(c) If no foot is built, build an unbounded right-headed foot.

Steps (a) and (b) produce the correct output for place names and loan words whenever they contain a heavy syllable, as illustrated below:[30]

(64)
```
        *            *           *
    (*   *)       (* *)         (*)
     antál<ya>  lokán<ta>     ánka<ra>
```

When neither the penult nor the antepenult is heavy, step (c) produces the correct output, as illustrated below:

(65)
```
       *
    (* *)
    kené<di>
```

Hammond does not discuss adverbials derived with *-en*, but his analysis, like that of Kaisse, would require a separate foot-building rule for these forms, a rule that is different from (63b).

While Hammond's analysis accounts for the facts of Turkish, it is not clear that the ROB foot is independently motivated in other languages. Besides Turkish, Hammond 1986 uses this foot type in the analyses of Khalkha Mongolian, Lenakel and Klamath. The preceding section presented an alternative analysis of Turkish stress using only independently motivated principles, and section 3.2 proposes an analysis of the

[30] I use asterisks rather than Hammond's lollipops for typographic convenience.

stress pattern of Khalkha Mongolian which does not use feet at all. The somewhat more complex stress patterns of Lenakel and Klamath are not discussed here, but alternative analyses are available which do not require an enrichment of metrical theory. For example, Hammond 1990b proposes an analysis of Lenakel which uses only syllabic trochees except for those instances in which heavy syllables attract stress. Under my approach, the latter may be handled via the Weight-to-Stress Principle, as outlined in section 2.3.3.2 and further illustrated in section 3.2. I conclude, therefore, that the ROB foot proposed in Hammond 1986 constitutes an otherwise unnecessary enrichment of metrical theory.

To summarize thus far, Hammond's analysis accounts for the stress pattern of place names and loan words. Like Kaisse, however, he proposes a foot type which constitutes an otherwise unnecessary enrichment of metrical theory. To the extent that other analyses are available which utilize independently motivated foot types, both Kaisse's and Hammond's accounts of Turkish must be considered *ad hoc*.

The analysis of Halle and Vergnaud 1987b is considered next. Halle and Vergnaud make a radical departure from both Kaisse 1985 and Hammond 1986 in proposing that feet in exceptionally-stressed Turkish words are unbounded. Their proposal is as follows:

(66) Halle and Vergnaud 1987b:

(a) Stressable elements are vowels.
(b) Assign line 1 asterisks to 'unstressable' suffixes and to the penultimate syllable of the stem of 'foreign' words.
(c) Line 0 parameter settings are [+HT, -BND, right].
(d) Construct constituent boundaries on line 0.
(e) Locate the heads of line 0 constituent on line 1.
(f) Line 1 parameter settings are [+HT, -BND, left].
(g) Construct constituent boundaries on line 1.
(h) Locate the heads of line 1 constituent on line 2.
(i) Conflate lines 1 and 2.
(j) Delete the line 0 asterisk of the stressed syllable if stress falls on an 'unstressable' suffix or on a 'foreign' word where the penult ends with a short vowel and the antepenult with a consonant.

Using the above set of rules, stress in place names and loan words may be derived as follows. First, if the antepenultimate syllable is light, then step j does not apply and stress falls on the penultimate syllable:

```
(67) Input:             Steps a-b:          Steps c-e:

                             *                   *   *
       *   *   *        *    *    *         (*    *) (*)
     k e n e d i        k e n e d i         k e n e d i

     Steps f-h:          Step i:             Step j:      Output:

         *                   *
       (*    *)            (*    .)
     (*   *) (*)        (*   *)   *
     k e n e d i        k e n e d i          N/A          kenédi
```

If the antepenultimate syllable is heavy, then step j deletes the penultimate line 0 asterisk, forcing stress to shift leftward to the antepenultimate syllable:

(68) Input:

```
 *     *   *
 a n k a r a
```

Steps a-b:

```
       *
 *     *   *
 a n k a r a
```

Steps c-e:

```
       *   *
(*     *) (*)
 a n k a r a
```

Steps f-h:

```
       *
      (*   *)
(*     *) (*)
 a n k a r a
```

Step i:

```
       *
      (*   .)
(*     *)  *
 a n k a r a
```

Step j:

```
 *
(*     .   .)
(*     .)  *
 a n k a r a
```

Output:

ánkara

Halle and Vergnaud do not discuss adverbials derived with the suffix *-en,* but the above account of stress in place names has some serious defects in and of itself. First, the use of unbounded feet would imply that stress may occur anywhere in a word, yet this is not the case in the class of words to which the rules in (66) apply. Apart from the effect of 'unstressable' suffixes, the stress window in place names and loan words (as well as in adverbials derived with *-en)* is in fact limited to the penultimate and antepenultimate syllables. In order to compensate for using a potentially unbounded stress window to account for a stress distribution that is in fact bounded, Halle and Vergnaud's analysis includes two rules, (66b) and j, which make explicit reference to the penultimate and antepenultimate syllables. Rule (66b) assigns a line 1 asterisk to the penultimate syllable of 'foreign' words. This ensures that the penultimate syllable will be stressed in every such word except when rule (66j) applies, in which case stress will shift leftward exactly one syllable.

Oddly enough, Halle and Vergnaud criticize Hammond's analysis of Turkish on the basis of the fact that Hammond's stress rules have direct

access to information about syllable weight, and yet Halle and Vergnaud's rule (66j) also has direct access to information about syllable weight. Furthermore, as Hayes 1991 points out, Halle and Vergnaud fail to offer a formal explanation of how rule (66j) is able to identify the penultimate and antepenultimate syllables.

In summary, Halle and Vergnaud's proposal is overly complex in that (i) it constructs unbounded feet even though the stress window is bounded and (ii) rule (66j) refers to the penultimate and antepenultimate syllables without any formal explanation as to how it is able to identify these syllables. In contrast, all the other analyses considered thus far limit the stress window by constructing bounded (i.e., maximally binary) feet on line 0.[31]

I turn now to the analysis proposed in Hayes 1991, stated below:

(69) Hayes 1991:

(a) Consonant Extrametricality: $C \rightarrow \langle C \rangle$ / ___ $]_{word}$

(b) Foot Construction: Build moraic trochees iteratively from right to left.

(c) Foot Extrametricality: Foot → <Foot> / x ___

(x = clashing stress)

(d) End Rule Right[32]

---

[31]Actually, both Kaisse and Hammond allow the word tree, which is unbounded, to be constructed on line 0, but only after foot construction has failed in its attempt to apply.

[32]In this case, Hayes uses the End Rule to eliminate all but one stress rather than to simply elevate one stress above the others. This is necessary in order to prevent the occurrence of secondary stress in longer forms such as *katakúlli (*kàtakúlli)*. Except in this instance

The application of this set of rules to place names is illustrated below:

(70)

Input:	Consonant EM:	Foot Construction:
kenedi	N/A	.(x .) kenedi
Foot EM:	**End Rule Right:**	**Output:**
N/A	(x) .(x .) kenedi	*kenédi*

(71)

Input:	Consonant EM:	Foot Construction:
ankara	N/A	(x) (x .) ankara
Foot EM:	**End Rule Right:**	**Output:**
(x)<(x .)> an kara	(x) (x)<(x .)> ankara	*ánkara*

Hayes points out that regular final stress may be derived simply by applying End Rule Right directly to the word, without building any feet. This is essentially equivalent to the autosegmental analysis of regular stress that was proposed in the preceding section. Notice, however, that Hayes' rule (69c) is unprecedented in metrical theory. The idea of marking a foot extrametrical is not unreasonable in itself. For example, Ishihara 1991 derives a three-mora window for tonal association in Japanese via a rule that renders a peripheral foot extrametrical, and

---

where the analysis is not my own, I assume that the End Rule normally elevates one stress above the others.

Hayes 1991 proposes a similar rule for Palestinian Arabic. The problem with (69c) lies not in the fact that it renders a foot extrametrical, but rather in the fact that the rule is triggered by a clashing stress. Although rules of stress clash are common in the literature on stress, they normally serve only to resolve the clash via the deletion of an immediately adjacent stress.[33] Apart from rule (69c), no one has ever suggested that a stress clash could trigger a rule of extrametricality. Such a rule neither resolves nor ignores the clash. For this reason, Hayes' account of Turkish exceptional stress remains suspect.

In summary, each of the above proposals has serious theoretical complications associated with it. The analyses of Kaisse 1985 and Hammond 1986 utilize OB and ROB feet, respectively, each of which constitutes an otherwise unnecessary enrichment of metrical theory. Halle and Vergnaud's proposal, while appearing to provide a uniform account of exceptional stress, creates unbounded feet on line 0, thus obscuring the fact that Turkish stress has a limited stress window. Hayes' 1991 analysis utilizes an unprecedented rule in which extrametricality applies only in case of a stress clash.

In contrast to each of these approaches, the autosegmental analysis of Turkish utilizes a simple set of rules which capture the observation that exceptional stress assignment makes use of a moraic foot while regular stress assignment does not. This analysis is superior to one which utilizes an iambic foot to account for place names and loan words, for only a moraic foot is able to account for the stress pattern of the

[33]See Hammond 1988a for examples of such rules.

former as well as the stress pattern of adverbials derived with *-en;* an iambic foot cannot be used for the latter. Moreover, the stress pattern of Turkish place names and loan words has been shown to instantiate the existence of the right-stressed moraic foot, which is predicted by the autosegmental theory of stress but not by Hayes' theory.

3.1.2.3. Summary of Moraic Stress Systems.

The foregoing discussion utilized data from Cairene Arabic and Turkish to instantiate the two logically possible surface combinations of a stress autosegment with a moraic foot. It was shown that Cairene Arabic has left-stressed moraic feet in surface representation, and the evidence from secondary stress supports the claim that this language does not allow degenerate feet. Certain Turkish words (i.e., place names and loan words) were shown to contain right-stressed moraic feet, and the remaining facts of Turkish stress support the claim that stress is autosegmental. It was argued that each of the alternative proposals for Turkish stress has theoretical complications associated with it, whereas the autosegmental analysis employs only independently required principles and devices.

Next, I examine the implications of asymmetric stress systems for the autosegmental theory of stress.

3.1.3. Asymmetric Stress Systems.

Section 2.3.3.2 claimed that the independence of the directionality parameter and foot type is overruled by the Weight-to-Stress Princi-

ple in the case of asymmetric feet. Specifically, canonical (i.e., asymmetric) iambic stressed feet behave as though they had inherent heads because of the tendency for stress to be attracted to heavy syllables. Thus, my proposal makes no new empirical predictions about the properties of asymmetric stress systems other than the claim that heads are not needed and that stress does not have to be assigned at the time of foot construction. But whenever stress autosegments *are* assigned, they have to link to the heavier member if the grammar has defined the foot as asymmetric.

In order to complete the instantiation of the typology of binary stressed feet, this section illustrates how the autosegmental theory of stress may be used to derive the iambic stress pattern of Hixkaryana that was discussed in chapter 1. Sample data are repeated below.[34]

(72) Hixkaryana (Derbyshire 1985, Hayes 1991):

khaná:nɨhno	*I taught you*
mɨhá:nanɨhno	*You taught him*
ówtohó:na	*to the village*
tóhkur^{y}é:hona	*to Tohkurye*
tóhkur^{y}é:honá:hašá:ka	*finally to Tohkurye*

As chapter 1 pointed out, Hayes 1991 derives this stress pattern by constructing iambic feet iteratively from left to right. He attributes the absence of final stress to a rule which marks the final syllable extrametrical. The only difference between Hayes' account and the one

[34]Notice that all stresses are written as primary. In fact, both Derbyshire 1985 and Hayes 1991 state that all of a word's stresses except one are secondary, and that main stress is determined not by metrical structure but by intonation.

proposed here is that the autosegmental theory of stress requires that the building of feet and the assignment of stress be stated as separate rules, whereas Hayes needs only one rule because his feet have inherent heads. My proposed rules are formalized below:

(73) Hixkaryana Stress Assignment:

(a) Make the final syllable extrametrical.

(b) Construct iambic feet iteratively from left to right.

(c) Insert * into each foot and link.

Before presenting sample derivations, two points need to be clarified regarding the rules in (73). First, I follow Hayes in assuming that the lengthening of stressed vowels in open syllables follows automatically from the fact that the grammar calls for iambic feet. Second, the direction of linking does not need to be stated in (73c) because the Weight-to-Stress Principle forces the stress autosegment to link to the heavier member of the foot.

With these two points in mind, the application of (73) to the underlying form *khananɨhno* produces the following derivation:

(74) Input: / Extrametricality: / Build Feet:

```
Input:                 Extrametricality:        Build Feet:

 σ   σ   σ     σ        σ   σ   σ    <σ>        (σ   σ) (σ)   <σ>
 |   |   |\    |        |   |   |\    |          |   |\  |\    |
 μ   μ   μ μ   μ        μ   μ   μ μ   μ          μ   μ μ μ μ   μ
 |   |   | |   |        |   |   | |   |          |   |/  | |   |
kha  na  nɨ h  no      kha  na  nɨ h  no        kha na   nɨ h  no
```

<u>Insert & Link *</u>: Output:

```
      *    *
      |    |
 (σ   σ)  (σ)   <σ>
  |   |\   |\     |
  μ   μ μ  μ μ    μ
  |   |/   | |    |
 kha  na   nɨ h   no        khaná:nɨ́hno
```

The foregoing analysis crucially assumes that a lone light syllable cannot form a degenerate foot. If it could, then one would expect to find forms such as **tóhkur^{y}é:hó:na* instead of the observed *tóhkur^{y}é:hona*. The derivation of this word is illustrated below.

(75) Input:

```
 σ      σ    σ    σ    σ
 |\     |    |    |    |
 μ μ    μ    μ    μ    μ
 | |    |    |    |    |
 to h   ku   r^ye ho   na
```

Extrametricality:

```
 σ      σ    σ    σ  <σ>
 |\     |    |    |    |
 μ μ    μ    μ    μ    μ
 | |    |    |    |    |
 to h   ku   r^ye ho   na
```

Build Feet:

```
 (σ)   (σ      σ)    σ  <σ>
  |\    |      |\    |    |
  μ μ   μ      μ μ μ μ    μ
  | |   |      |/    |    |
  to h  ku     r^ye  ho   na
```

Insert & Link *: Output:

```
  *            *
  |            |
 (σ)   (σ      σ)    σ  <σ>
  |\    |      |\    |    |
  μ μ   μ      μ μ μ μ    μ
  | |   |      |/    |    |
  to h  ku     r^ye  ho   na        tóhkur^yé:hona
```

To summarize, the grammar of Hixkaryana constructs iambic feet iteratively from left to right and inserts * into each foot. The fact that feet are right-stressed is attributed to the Weight-to-Stress Principle. Since feet are iambic, the heavier syllable is on the right, and this is the syllable that has to be stressed.

This concludes the instantiation of the predicted typology of binary stressed feet. Next, I instantiate the various ways in which a grammar may apply the Weight-to-Stress Principle using the word rather than the foot as the domain in which stress is inserted and linked.

3.2. Deriving 'Unbounded Feet' via the Weight-to-Stress Principle.

Prince's Weight-to-Stress Principle was invoked in the preceding section in order to reconcile the claim that feet are inherently headless with the observed asymmetric distribution of stress in languages with asymmetric feet. This section uses this same principle to account for stress systems in which stress is assigned to heavy syllables without regard for how close they occur to the edge of the representation. This class of stress system is what Hayes 1981, 1987 and 1991 refers to as *unbounded quantity sensitive*.

Examples of languages with unbounded quantity sensitive stress include Khalkha Mongolian, Yana, Aguacatec Mayan, Huasteco, Eastern Cheremis, Komi, Waalubal, Koya and Western Greenlandic Eskimo; each of these is discussed and further classified below. The interesting feature of each of these languages is that stress may occur anywhere in the word depending only on the location of heavy syllables. Section 2.1.1 pointed out that Hayes' Bijectivity Principle, which claims that there is a one-to-one correspondence between prominence and constituency, forces him to conclude that the grammars of these languages construct unbounded feet. In contrast, I have argued for and adopted Prince's 1983, 1990 conclusion that unbounded feet do not exist. Consequently, I

claim that stress assignment is achieved in each of these languages via Prince's Weight-to-Stress Principle, i.e., without the use of feet. This section utilizes the Weight-to-Stress Principle in the analysis of some of the above-named languages and argues that all and only those 'unbounded' patterns which are predicted by the autosegmental theory of stress are attested.

What unbounded patterns are predicted by the autosegmental theory of stress? Basically, only two kinds of rules are available for assigning stress to any domain. One of these is the directional linking of a stress autosegment to the edge of the domain and the other is Weight-to-Stress. Each of these rule types has already been instantiated for cases in which the foot is the relevant domain, and regular Turkish stress (section 3.1.2.2.1) instantiates the directional linking of stress to the edge of a word. In addition to these rules, it is possible for a grammar to apply Weight-to-Stress to the word domain in one of two ways. Either Weight-to-Stress can apply to every heavy syllable, or else it can apply to at most one heavy syllable. In the latter case, the grammar must specify in which direction it scans for a heavy syllable.

This would seem to result in three possible unbounded stress patterns: stress the leftmost heavy syllable, the rightmost heavy syllable or all heavy syllables. However, Prince 1983 (page 74) points out that Weight-to-Stress (which he refers to as quantity sensitivity) must always be supplemented by other stress assignment rules. If this were *not* true, then we would expect to find languages in which stress is assigned

only via Weight-to-Stress. In such a language, words lacking heavy syllables would surface without stress. It appears that no such language exists. I follow Prince in concluding, therefore, that Weight-to-Stress can never be the exclusive means of deriving stress.

As Prince observes, this makes sense if stress is viewed as an obligatory element in the output of every word. Since there appears to be no way for a grammar to ensure that every word will have at least one heavy syllable at the point in the derivation where stress assignment applies, Weight-to-Stress cannot be relied upon to produce stress in every word. Consequently, although it is possible for a grammar to invoke the other kind of stress rule (i.e., directional linking to the domain's edge) without invoking Weight-to-Stress, it does not appear to be possible for a grammar to invoke Weight-to-Stress without invoking the other type of stress rule as well. Consequently, the autosegmental theory of stress admits exactly six possible types of unbounded stress. These six types are derived by combining the three possible Weight-to-Stress rules (stress the leftmost, rightmost or all heavy syllables) with the other two possible rules (link a stress to the left/right edge of the word).[35]

In what follows, each of these six possibilities is instantiated. I begin with a discussion of Khalkha Mongolian.

---

[35]As mentioned earlier, it is also possible for a grammar to choose only to link a stress autosegment directly to the edge of a word without using Weight-to-Stress at all. Old English (Hagberg, in prep) instantiates the case where the leftmost syllable is stressed, and Turkish instantiates a grammar which stresses the rightmost syllable.

The Khalkha Mongolian data are presented below. The generalization is that the first long vowel of the word gets stressed; if there are no long vowels in a word, then the first vowel is stressed.

(76) Khalkha Mongolian (Street 1963):

bosgúul	*fugitive*
garáasaa	*from one's own hand*
bariáad	*after holding*
áli	*which*
xoyərdugáar	*second*
xótəlbərə	*leadership*

Notice that some of the words in (76) contain strings of two or three stressless syllables, and the location of each of these strings of stressless syllables is determined only by the location of the first long vowel. Following Prince's 1990 claim that unbounded feet do not exist and in the absence of evidence for foot structure in Khalkha Mongolian, I propose the following rules of stress assignment:[36]

(77) Autosegmental Analysis of Khalkha Mongolian:

(a) Apply the Weight-to-Stress Principle non-iteratively from left to right.

(b) End Rule left.

Following Prince 1983 and Hayes 1991, I assume that the End Rule applies to line 0 if there are no asterisks on line 1, i.e., if Weight-to-Stress has been unable to apply because there are no heavy syllables. The application of these rules is illustrated below:

[36]For other analyses of Khalkha Mongolian stress, see Hayes 1981, Hammond 1986 and Halle and Vergnaud 1987b.

```
(78) Input:           Weight-to-Stress:   End Rule:        Output:

                                                 *
                               *          (      *  )
                               |                 |
     μ μ  μ μ μ        μ μ  μ μ μ         μ μ  μ μ μ
     | |  | |/         | |  | |/          | |  | |/
    xoyərdugar        xoyərdugaar        xoyərdugaar      xoyərdugáar
```

```
(79) Input:           Weight-to-Stress:   End Rule:        Output

                                          *
                                          |
     μ μ                                  μ μ
     | |                                  | |
     ali                  N/A             ali              áli
```

```
(80) Input:           Weight-to-Stress:   End Rule:        Output:

                                            *
                         *                (  *      )
                         |                   |
      μ μ μ μ μ        μ μ μ μ μ          μ μ μ μ μ
      | |/  |/         | |/  |/           | |/  |/
     gara  sa          gara  sa           gara  sa         garáasaa
```

To summarize the above account, (77a) assigns stress to the leftmost long vowel in any word that contains one or more long vowels, and (77b) assigns initial stress to words which lack long vowels. Thus, by applying Prince's Weight-to-Stress Principle in conjunction with the established principles of autosegmental theory, the Khalkha Mongolian stress pattern is accounted for without the use of feet.

In fact, the above approach may be used to derive all of the types of putative unbounded stress systems that have been reported. As far as I know, the following list of types of unbounded systems is exhaustive:

(1) Stress the leftmost heavy syllable, else the first syllable;

(2) Stress the rightmost heavy syllable, else the final syllable;

(3) Stress the rightmost heavy syllable, else the first syllable;

(4) Stress the leftmost heavy syllable, else the final syllable;

(5) Stress every heavy syllable plus the first syllable;

(6) Stress every heavy syllable plus the final syllable.

These are listed in (81). Each column of the chart corresponds to one of the six types of 'unbounded' stress systems. There are three possibilities for Weight-to-Stress: It may apply non-iteratively from left to right, producing stress on the first heavy syllable; or it may apply non-iteratively from right to left, producing stress on the last heavy syllable; or it may apply iteratively, producing stress on *all* heavy syllables. With regard to the End Rule, however, there are only two possibilities: Either the first or the final stress is promoted.

(81) <u>Direction of Linking in 'Unbounded' Stress Systems</u>:

	Type 1	Type 2	Type 3	Type 4	Type 5	Type 6
Weight to Stress	L to R	R to L	R to L	L to R	All	All
End Rule	Left	Right	Left	Right	Left	Right

As was mentioned earlier, another set of stress patterns is also logically possible but unattested, as far as I know. This would be exemplified by any language in which stress is assigned via Weight-to-Stress (either non-iteratively or iteratively) but which lacks the End Rule.

In such a language, a word which lacks heavy syllables would surface without any stress.

In what follows, examples of each of the above stress patterns are discussed, and it is argued that all six types may be derived by applying the Weight-to-Stress Principle in combination with the End Rule.

Khalkha Mongolian, in which stress is assigned to the leftmost long vowel else the first vowel, has already been discussed as an example of type 1. Yana (Sapir and Swadesh 1960, Hayes 1981) works in exactly the same way, except that the grammar of Yana has a different definition for heavy syllable than that used by the grammar of Khalkha Mongolian.

Aguacatec Mayan (McArthur and McArthur 1956, Hayes 1981) exemplifies type (2). The analysis is identical to (77) except that, in this case, the direction of application for both rules is from right to left instead of from left to right.

Unlike types (1) and (2), in which the two rules of stress assignment are unidirectional, the rules of stress assignment for type (3) apply in opposite directions, and this is also the case for type (4). In order to see this, consider first the following data from Huasteco (repeated from section 2.1.1). Huasteco is an example of type (3): Stress occurs on the rightmost long vowel, else the first vowel.

(82) <u>Huaṣteco</u> (Larsen and Pike 1949):

?á:ṣ̌uṣ̌lom	*field of garlic*
k^{w}'ahí:lom	*widow*
?alaɓé:l	*pretty*
hu:čú:k'čik	*blisters*
bi:nomá:c	*one who gave*
e:la:ṣ̌wá:y	*(they) surely find each other*

cabá:l	*earth*
cábal	*cooked corn*
?át'em	*salt*
cálam	*shade*
k^w'áθap	*tarantula*
hílk'omač	*leftovers*

In order to derive this distribution of stress, the Weight-to-Stress Principle must apply from right to left as in type (2), even though the End Rule applies from left to right as in type (1); this is stated in (83).

(83) Autosegmental Analysis of Huasteco:

(a) Apply the Weight-to-Stress Principle from right to left.

(b) End Rule left.

Thus, in words containing at least one long vowel, the stress pattern is exactly like that of type (2), i.e., on the rightmost long vowel. This is illustrated in (84) and (85).

```
(84) Input:         Weight-to-Stress:   End Rule:         Output:

                                        *
                    *                   (*        )
                    |                   |
     μ μ μ  μ       μ μ μ  μ            μ μ μ  μ
     |/  |  |       |/  |  |            |/  |  |
     ?a  ṣuṣlom     ?a  ṣuṣlom          ?a  ṣuṣlom        ?á:ṣuṣlom
```

```
(85) Input:         Weight-to-Stress:   End Rule:         Output:

                                                  (*)
                              *                    *
                              |                    |
     μ μ μ μ μ μ    μ μ μ μ μ μ         μ μ μ μ μ μ
     |/  |/  |/     |/  |/  |/          |/  |/  |/
     e   laṣ way    e   laṣ way         e   laṣ way       e:la:ṣwá:y
```

Type (3) differs from type (2), however, with respect to the assignment of stress to words which lack vowel length. In type (3) systems, these words are stressed on the *initial* syllable instead of on the final syllable, as in type (2) systems. Hence, the End Rule has to apply from left to right, as illustrated in (86).

(86) <u>Input</u>:	<u>Weight-to-Stress</u>:	<u>End Rule</u>:	<u>Output</u>:
μ μ | | cabal	N/A	* | μ μ | | cabal	*cábal* **cabál*

Hence, Huasteco illustrates type (3) 'unbounded' stress; it differs from type (1) in that the Weight-to-Stress Principle applies from right to left instead of from left to right, but it also differs from type (2) in that the End Rule applies from left to right. Eastern Cheremis (Ingemann and Sebeok 1961, Hayes 1981) is another example of a type (3) 'unbounded' stress system.

Type (4) is the mirror image of type (3) in that, in type (4), the Weight-to-Stress Principle applies from left to right and the End Rule applies from right to left. Komi (Hayes 1981) is an example of such a system.

Waalubal (Crowley 1978, Hammond 1989b) and Koya (Tyler 1969, Hayes 1981) are examples of type (5). In each of these languages, main stress is assigned to the first syllable and secondary stress is assigned to each non-initial long vowel, as may be seen in the following data from Waalubal.

(87) Waalubal (Crowley 1978, Hammond 1989b):

bándaŋ	*other*
báɲɟanibè:	*only covered*
wúrgulù:m	*magpie*
ŋámà:lu	*tree goanna (ERG)*
bá:ɲbini	*took out*

In order to account for the stress pattern in (87), three rules are needed instead of two. First, a stress autosegment is inserted and linked in the word from left to right. This differs from the End Rule in that the latter normally serves only to promote a previously-generated stress; it generates a stress only when the normal stress-generating rules have been unable to apply. In contrast, the new rule which I am proposing for Waalubal generates first-syllable stress in every word. Following the application of this rule, the Weight-to-Stress Principle is applied iteratively.[37] Finally, the distinction between primary and secondary stress is derived by applying End Rule left. This is illustrated below.

```
(88) Input:        Assign * to Word:   Weight-to-Stress:   End Rule:

                                                            *
                    *                   *       *           (*      *)
                    |                   |       |           |       |
     μ  μ  μ μ      μ  μ  μ μ           μ  μ  μ μ           μ  μ  μ μ
     |  |  |/       |  |  |/            |  |  |/            |  |  |/
    wur gu lum     wur gu lum          wur gu lum          wur gu lum
```

Output:

wúrgulù:m

[37]Actually, as far as I can tell, the relative order of these two rules doesn't matter.

```
(89) Input:      Assign * to Word:   Weight-to-Stress:   End Rule:

                                                          *
                  *                                      (*   )
                  |                                       |
     μ  μ         μ  μ                                    μ  μ
     |  |         |  |                                    |  |
     bandaŋ       bandaŋ                N/A               bandaŋ
```

Output:

bándaŋ

```
(90) Input:      Assign * to Word:   Weight-to-Stress:   End Rule:

                                                          *
                  *                                      (*      )
                  |                                       |
     μ μ μ μ      μ μ μ μ                                 μ μ μ μ
     |/   | |     |/   | |                                |/   | |
     baɲ bini     baɲ bini          Blocked by OCP        baɲ bini
```

Output:

bá:ɲbini

The use of three rules instead of two in the above analysis raises the following question. Is there a grammar which, like Waalubal, invokes Stress-to-Word from left to right and applies Weight-to-Stress iteratively but which, unlike Waalubal, applies End Rule right instead of End Rule left? The answer appears to be no. The reason, I believe, is that the End Rule and Stress-to-Word are redundant. (Notice that the corresponding analyses of Hayes 1981, 1991 and H&V contain parallel redundancies). One way of eliminating this redundancy from my theory is to eliminate the End Rule. If a grammar calls for exactly one stress per word, then Weight-to-Stress and Stress-to-Word will be in complemen-

tary distribution, i.e., either one or the other will apply in any given word, but not both. If, however, a grammar invokes Weight-to-Stress iteratively, this is tantamount to saying, 'Assign as many stresses to a word as you can.' Since the rule of Stress-to-Word has to be available to derive stress in words with only light syllables, it applies whenever it can, even in words with heavy syllables. See Hammond's 1990b discussion of directionality for another approach to eliminating redundancy from metrical theory.

The stress pattern of Koya is just like that of Waalubal, except for the fact that Koya assigns * from left to right to each *phrase* rather than to each word, as in Waalubal.[38] West Greenlandic Eskimo (Schultz-Lorentzen 1945, Hayes 1981) is an example of type (6) 'unbounded' stress. In this language, stress occurs on each heavy syllable plus the final syllable, so the analysis is essentially the same as in Waalubal and Koya except that the word-level * links from right to left instead of from left to right. Thus, the one feature of types (5) and (6) 'unbounded' stress systems which distinguishes them from the other four types is that types (5) and (6) assign a stress to *every* heavy syllable rather than to just one.[39] This difference may be ac-

---

[38]Hayes 1981 claims that Koya has primary stress on the initial syllable and secondary stress on each heavy syllable, but Tyler 1969 states only that long vowels are stressed and that each stress is equal except for the first stress of the phrase, which is stronger than the other stresses. It is not clear from Tyler's account whether the first stress of the phrase occurs on the first long vowel or simply on the first vowel.

[39]Additionally, types (5) and (6) require a rule assigning stress to a peripheral syllable in every word, as explained above.

counted for by assuming that Weight-to-Stress may apply either non-iteratively, as in types (1) through (4), or iteratively, as in types (5) and (6).

Notice that these six configurations of 'unbounded' stress systems are the only ones that may be derived by combining Weight-to-Stress with Stress-to-Word. This is because there are only two possible directions in which a rule may apply. Combining each of the two rules with each of the two possible directions gives only four logically possible combinations; these correspond to types (1) through (4). Types (5) and (6) represent those cases in which the direction of application of Weight-to-Stress is irrelevant because it applies to *every* heavy syllable. The only difference, then, between types (5) and (6) is in the direction of application of Stress-to-Word.

Halle and Idsardi 1992 propose a different approach to unbounded stress systems. Instead of applying Weight-to-Stress, they propose the Projection parameter, which projects the boundary of certain syllables (generally, heavy ones) onto line 0. The effect of this parameter is the same as that of the Weight-to-Stress Principle. While the Projection parameter is capable of generating all of the attested unbounded systems, it is subject to all of the arguments that were raised in chapter 2 against the existence of unbounded feet. In contrast, these arguments do not apply to the autosegmental approach to 'unbounded' stress because this approach does not build feet.

In summary, each of the six attested types of putatively unbounded stress systems is accounted for straightforwardly under the autosegmen-

tal theory of stress. Furthermore, the latter predicts that these six basic systems are the only ones that may be derived using the Weight-to-Stress Principle. The separation of prominence and constituency is precisely what makes it possible to analyze these stress systems without resorting to the use of unbounded feet. Consequently, I conclude that these stress systems do not constitute an argument for the existence of unbounded feet. In fact, I know of no compelling argument for the existence of unbounded feet, and the Autosegmental Stress Hypothesis makes it possible to account for these systems without using feet at all.

3.3. Summary.

The preceding sections have instantiated the stress typology that is predicted by the theory that was proposed in the preceding chapter. This chapter was organized in terms of the traditional distinction between bounded and unbounded feet. Section 3.1 instantiated the predicted typology of binary stressed feet with data from Warao, Mayo, Cairene Arabic, Turkish and Hixkaryana. The first four of these languages exemplify the four logically possible surface combinations of a stress autosegment with a symmetric foot. The final language, Hixkaryana, was presented as an example of how a stress autosegment links to an asymmetric foot. Following Prince 1990, the total absence of stress systems which stress the weak member of an asymmetric foot is explained by the Weight-to-Stress Principle. That is, the otherwise-free ability of a grammar to combine any foot type with any direction of

linking of a stress autosegment is overruled by the asymmetry of the iambic foot.

Section 3.2 applied the Weight-to-Stress Principle to derive what has traditionally been known as 'unbounded' stress. It was argued that all and only the attested patterns of unbounded stress are predicted to occur if the Weight-to-Stress Principle is allowed to apply in the domain of the word.

This completes the instantiation of the various stress patterns that are predicted by the autosegmental theory of stress. The next two chapters provide further arguments for the two key claims of the theory, i.e., that stress and metrical structure are logically separate and that stress is autosegmental. Chapter 4 presents a detailed analysis of the facts of stress and vowel length in Yidin^y, a language of Australia, and argues that the autosegmental approach to Yidin^y stress is superior to the proposals of Hayes 1982b, Halle and Vergnaud 1987b and Hammond 1990b. In particular, it is argued that feet which surface with stress in Yidin^y are initially built without stress and remain stressless throughout part of the derivation. Furthermore, the Weight-to-Stress Principle is used to assign stress to the rightmost heavy syllable in a word in essentially the same manner as in some of the derivations in section 3.2. Chapter 5 takes a closer look at the nature of Mayo's floating accent and describes a similar phenomenon in Tagalog. Further evidence for the autosegmental nature of stress is deduced from base transfer effects in Mayo reduplication and from the interaction of segmental length and stress assignment in Mayo.

CHAPTER 4

HEADLESS FEET IN YIDIN^y

Chapter 2 demonstrated that Yidin^y has a vowel lengthening rule which intervenes between the construction of stressless (and headless) feet and the assignment of stress. The requirement for this particular ordering of the rules was invoked as an argument for the claim that feet are inherently headless. However, chapter 2 did not discuss the question of how Yidin^y stress is formally assigned to feet. This chapter proposes an autosegmental analysis of stress and vowel length in Yidin^y and compares it to other analyses that have been proposed, concluding that the facts of Yidin^y are best accounted for by a theory in which all feet, including stressed feet, are headless.[1]

The chapter begins by reviewing the basic facts of Yidin^y that were presented in chapter 2. Then, section 4.2 presents the autosegmental analysis. Section 4.3 reviews the analyses of Hayes 1982b, Halle and Vergnaud 1987b and Hammond 1990b and argues that each has one or more theoretical problems associated with it. It is concluded that the autosegmental analysis of Yidin^y stress is free of the problems that are raised by the other proposals precisely because the autosegmental analysis separates constituency from prominence. This, then, constitutes an argument in favor of the inherent headlessness of feet, which is a foundational principle of the autosegmental theory of stress.

[1]As was mentioned in section 2.1.2.2, Crowhurst 1991a and Crowhurst and Hewitt (to appear) argue for analyses that are quite similar to the one presented here. However, although the above works initially construct headless feet, they later assign heads to them. In contrast, I argue that all feet are headless.

4.1. The Empirical Basis for Iterative Headless Foot-Building.

Dixon's 1977 generalization regarding Yidin^y stress is as follows (repeated from section 2.1.2.2):

(1) Stress Assignment Rule (Dixon 1977):

> Stress is assigned to the first syllable involving a long vowel. If there is no long vowel, it is assigned to the first syllable of the word. Further stresses are then assigned (recursively) to the syllable next but one before, and the next but one after, a stressed syllable.

A subset of Dixon's Yidin^y data is repeated below from chapter 2. Notice that long vowels are always stressed and that vowel length may occur anywhere in the word, although neither length nor stress surfaces on adjacent vowels.[2] Furthermore, stress occurs either on every even-numbered syllable, as in (2), or on every odd-numbered syllable, as in (3), depending upon the location of long vowels.

(2) Stress on Even-Numbered Syllables:

bulmbá:	*at the camp*
galí:n^y	*go-PAST*
gudá:ga	*dog*
yabú:lam	*loya cane*
yad^{y}í:riŋál	*walk about-GOING-TRANSITIVIZER-PRESENT*
wawá:lin^{y}ú	*see-GOING-PAST*
ŋunáŋgará:	*in/on the whale*
mad^{y}índaŋá:d^{y}iŋ	*walk up-TRANSITIVIZER-ANTIPASSIVE-PRESENT*
d^{y}uŋgá:riŋá:lna	*run-GOING-TRANSITIVIZER-PURPOSIVE*

---

[2] It is possible for length to occur on adjacent vowels prior to the end of the derivation, but one of these vowels always gets shortened via Dixon's rule of Illicit Length Elimination, which shortens a long vowel in an odd-numbered syllable of a word containing an odd number of syllables. This lends support to the claims, for which I argue below, that all stress is derived on the basis of the surface location of long vowels, and that vowel length may be either underlying or derived.

(3) <u>Stress on Odd-Numbered Syllables</u>:[3]

gáliŋá:d^{y}iŋ	*go-TRANSITIVIZER-ANTIPASSIVE-PRESENT*
wúŋabá:d^{y}in^{y}únda	*hunt-ANTIPASSIVE-SUBORDINATE-DATIVE*

If there are no long vowels, then stress occurs on odd-numbered syllables, as in (4). Furthermore, all such words contain an even number of syllables.

(4)

múd^{y}am	*mother-ABSOLUTIVE*
wáṛil	*doorway-ABSOLUTIVE*
gálbin	*son-ABSOLUTIVE*
ŋúnaŋgára	*whale*
gúdagágu	*dog-PURPOSIVE*

Section 2.1.2.2 demonstrated that Yidin^y has a rule which lengthens the penultimate vowel of a word if it contains an odd number of syllables. It was argued that this rule, coupled with the dependence of stress assignment upon the surface distribution of long vowels, requires that foot-building be separated from stress assignment. This is because the assignment of stress has to follow the lengthening rule, which itself must be preceded by foot-building.

Because of this requirement that foot-building be ordered before the assignment of stress, Yidin^y provides an argument for the claim that feet are inherently headless. As further evidence for this claim, in what follows it is argued that the Weight-to-Stress Principle applies in Yidin^y even though foot-building is insensitive to syllable weight, i.e., even though feet are built from syllables rather than from moras.

---

[3]These are the only two examples of vowel length occurring on odd-numbered syllables that I could find in Dixon 1977. The rarity of such forms may be attributed to the rule of Penultimate Lengthening coupled with Illicit Length Elimination, which shortens stressless long vowels.

In a theory such as that of Hayes 1991, the inherent headedness of feet makes it impossible to simultaneously account for both quantity insensitive foot-building and quantity sensitive stress assignment without resorting to stipulatory measures.

These points are developed in section 4.3, where Hayes' analysis (along with two others) is reviewed. First, however, I demonstrate how the autosegmental theory of stress may be used to account for the facts of Yidin^y in a non-stipulatory manner.

4.2. An Autosegmental Analysis of Yidin^y Stress.

In this section the following analysis of Yidin^y stress is proposed. First, syllabic feet are built iteratively from left to right. These feet have to be syllabic because the environment for Penultimate Lengthening makes reference only to syllable count, with no regard to quantity sensitivity. The facts of reduplication provide independent evidence for this conclusion. Reduplication in Yidin^y always copies the first two syllables of the stem, no more and no less, as illustrated in (5) through (7).[4]

(5) gudá-gudá:ga	*dog-REDUPLICATED (ABSOLUTIVE)*
(6) mulá-mulá:ri	*man-REDUPLICATED (ABSOLUTIVE)*
(7) kála-kálaMpára[5]	*March fly-REDUPLICATED (ABSOLUTIVE)*

---

[4]The data in (5) through (7) are from Nash 1979 and McCarthy and Prince 1990.

[5]The [M] in this form belongs to the onset (ka.la.Mpa.ra); it is not a coda (*ka.laM.pa.ra). The same is true of the word-medial velar nasal in *ŋúnaŋgára* (figure 4).

As section 2.1.2.1 explained, McCarthy and Prince 1986, 1987 and 1990 argue that every reduplication process copies a single prosodic structure such as a syllable or a foot. Since two syllables are consistently copied in the above data, it must be the case that the base of reduplication is the first disyllabic foot of the stem; there is no other prosodic unit which consists of exactly two syllables.

There are two potential objections to the use of the above reduplication data as an argument for the claim that Yidin^y's stressed feet are syllabic. First, one might object to the assumption that the feet used in reduplication are the same as the feet used in stress assignment. Indeed, McCarthy and Prince 1990 argue that many templatic morphological processes in Arabic languages use feet which are different from the feet used in stress assignment. Nevertheless, it is standard practice in linguistic analysis (indeed, in all scientific endeavors) to provide positive evidence for each degree of complexity that is proposed. The fact that different kinds of feet are utilized for two different processes in Arabic does not imply that this must be the case in Yidin^y. On the contrary, the burden of proof lies with those who would propose that Yidin^y uses a different foot type for the two processes (i.e., reduplication and stress assignment) which make use of feet. Thus, in the absence of evidence to the contrary, I conclude that the feet used in Yidin^y reduplication are the same as those which participate in stress assignment.

The second potential objection concerns the question as to whether Yidin^y's reduplication process actually copies the first foot of the

stem or whether it instead affixes a foot template and later copies its melody from the stem without regard to stem-internal foot boundaries. McCarthy and Prince 1986, 1990 address this question and conclude that the reduplication in forms such as (5) through (7) cannot simply be attributed to the affixing of a foot-sized template which later copies its melody from the stem. Indeed, this is observed in the remotely related language Lardil (Wilkinson 1986), as illustrated below.

(8) parel-pareli *gather (iteratively)*

In (8), the reduplication process copies more than the first two syllables from the base, and yet the resulting prefix consists of exactly two syllables. This means that Lardil affixes a templatic foot and uses the entire stem as its base. In contrast, the Yidin^y reduplication process literally parses off the first foot of the stem and copies that foot in its entirety. If reduplication in Yidin^y worked exactly like it does in Lardil, then one would expect to observe **mulár-mulári* instead of *mulá-mulári*. Thus, it must be the case that the Yidin^y reduplication process actually copies the first foot of the stem.

In summary, the facts of reduplication provide an independent argument for the claim that the feet used in Yidin^y stress assignment are syllabic rather than moraic or iambic. Furthermore, notice that the reduplicated foot is right-stressed in (5) and (6) and left-stressed in (7). This supports the conclusion, argued for below on independent grounds, that both directions of linking of the stress autosegment are attested in Yidin^y.

Next, after syllabic feet have been built, Penultimate Lengthening applies so as to insert a mora into a syllable preceding an unfooted syllable, as shown in (9).[6]

(9) Input: Penult Lengthening:

```
(9)  Input:                      Penult Lengthening:

      (σ   σ)  σ                  (σ   σ  )   σ
      /|   /|  /|                 /|   /|\    /|
     | μ | μ | μ                 | μ | μ μ  | μ
     | | | | | |                 | | | |/   | |
     g u d a g a                 g u d a    g a
```

Next, Prince's Weight-to-Stress Principle applies non-iteratively from right to left to a foot-bound heavy syllable.[7] *Foot-bound* means that the domain of application of Weight-to-Stress is the foot, so the target syllable has to be a member of a foot; this is discussed further below. Finally, a stress is inserted into each remaining foot and linked.[8] The direction of linking (within the foot) is from left to right unless this would result in a word whose feet are non-uniformly stressed. If the latter is the case, then linking will occur from right to left in order to satisfy the Uniform Linking Constraint (section 2.3.3.4). Thus, the location of the rightmost (foot-bound) heavy syllable determines the direction of linking of the stress autosegment for all feet within a given word. These steps are illustrated in (10).

[6]The exact formalization of Penultimate Lengthening is not relevant to the autosegmental theory of stress.

[7]In Yidin^y, a heavy syllable is one which contains a long vowel. Weight-to-Stress is defined and illustrated in sections 2.3.3.2, 3.1.3 and 3.2.

[8]The OCP blocks the application of this rule to the foot that received stress earlier via the application of Weight-to-Stress.

(10) <u>Output of (9)</u>: <u>Weight-to-Stress</u>: <u>Insert * & Link</u>:

```
                                 *
                                 |
 (σ   σ  )  σ              (σ    σ  )  σ
 /|  /|\   /|              /|   /|\   /|
| μ | μ μ | μ             | μ | μ μ | μ
| | | |/  | |             | | | |/  | |
g u d a   g a             g u d a   g a            N/A
```

<u>Output</u>:

gudá:ga

The reason for stipulating that Weight-to-Stress can apply only to a *foot-bound* heavy syllable is that it is possible, in principle, for underlying vowel length to occur on a final odd-numbered syllable. Although there are no instances of this in Dixon's data, underlying vowel length does occur on the ultima in some words with an even number of syllables, so it could presumably occur on a final odd-numbered syllable as well. According to Dixon's description of the facts of vowel length alternations, a final odd-numbered long vowel would be expected to undergo shortening (which follows stress assignment) and surface as stressless. Therefore, in order to force the Weight-to-Stress process to skip such a vowel and apply instead to the penultimate vowel, it is necessary to stipulate that Weight-to-Stress applies only to a footed string, i.e., it ignores unfooted syllables because the domain of application for this process is the foot. (See section 2.3.3.1 for discussion of the Foot-as-Domain Principle). Furthermore, I assume that this rule applies only once per word (i.e., non-iteratively) even though its domain of application is the foot rather than the word.

Another language in which Weight-to-Stress apparently applies only to a foot-bound heavy syllable is Capanahua, a language of Peru. The following is a summary of the relevant facts, taken from Loos 1969; the same data are found in Safir 1979.

According to Loos 1969, Capanahua has both stress and high tone.[9] These have distinct but predictable distributions which differ as follows. Stress occurs on the second syllable if it is closed (i.e., heavy), otherwise it falls on the first syllable. High tone, like stress, occurs on the second syllable if it is closed but, unlike stress, it falls on *each of the first two syllables* if the second syllable is *not* closed. Sample data from Loos 1969 (pages 186-94)and Safir 1979 are presented below. Following Safir, stress is marked by underlining and high tone is indicated by an acute accent.

(11)	č<u>ó</u>skó	*four*
	his<u>í</u>s	*ant*
	piṣ̌k<u>á</u>p	*small*
	s<u>ó</u>ntáko	*young girl*
	yos<u>á</u>nbo	*old woman*
	č<u>í</u>cíka	*knife*
	p<u>í</u>čáčikin	*to poke him in the ribs*
	nïṣ̌<u>í</u>ttani	*went and entangled himself*

Monosyllables lack stress and high tone, as shown below.

(12)	ta?	*DECLARATIVE MOOD*
	ra?	*perhaps*
	rïs	*just*
	?in	*I*
	min	*you*
	han	*he*

[9]The distinctive phonetic feature of stress is increased intensity (Eugene Loos, personal communication).

According to Loos 1969, the first three forms in (12) are clitics, but he classifies the other three as pronouns. If the latter are indeed free forms, then they constitute independent evidence for the claim, presented below, that the domain for both stress and tone assignment is the foot rather than the word.

In order to account for the above facts, the following analysis is proposed. First, syllabic feet are built iteratively from left to right, as illustrated below.

```
(13)   (σ      σ)          (σ    σ)    σ          σ
        /|\    /|           /|   /|\   /|         /|\
       | μ μ  | μ          | μ  | μ μ | μ        | μ μ
       | | |  | |          | |  | | | | |        | | |
       č o s  k o          y o  s a n b o        ? i n
```

Although high tone is sometimes assigned by rule to other syllables besides the first two, Loos 1969 reports that stress occurs only on the first or second syllable as described above. This might seem to indicate that foot-building is non-iterative, but Loos describes a rule of syllable-final glottal deletion which applies only to every other syllable proceeding from left to right across the word even in words of four or more syllables. As Safir 1979 points out, this indicates that foot-building is iterative and insensitive to syllable weight.

Next, Weight-to-Stress applies non-iteratively from left to right to a heavy syllable in the domain of the foot. In this case, a heavy syllable is defined as one which ends with a consonant. As in Yidin^y, it is necessary to stipulate that Weight-to-Stress can apply only within

the foot. Otherwise, Weight-to-Stress would be expected to apply to the monosyllabic forms in (12).

(14)

```
 *                  *
 |                  |
(σ     σ)      (σ   σ)    σ           σ
/|\    /|      /|  /|\   /|          /|\
| μ μ  | μ     | μ | μ μ | μ         | μ μ
| | |  | |     | | | | | | |         | | |
č o s  k o     y o s a n b o         ? i n    (*?ín)
```

Following Weight-to-Stress, a stress autosegment is inserted into the leftmost foot and links from left to right; the OCP blocks this from applying in a foot in which Weight-to-Stress has already applied (see section 1.2.4). Thus, stress occurs on the first syllable only if the second syllable is not heavy.[10]

In order to complete the above derivations, two tonal rules are needed. First, a high tone is inserted and linked to the stressed syllable. Second, a high tone spreads rightward within the foot, as illustrated below.

(15) (a) <u>Link H to a stressed syllable</u>:

```
 * H                * H
 |/                 |/
(σ     σ)      (σ   σ)    σ           σ
/|\    /|      /|  /|\   /|          /|\
| μ μ  | μ     | μ | μ μ | μ         | μ μ
| | |  | |     | | | | | | |         | | |
č o s  k o     y o s a n b o         ? i n
```

---

[10]By this analysis, a word in which both the first and second syllables are heavy would presumably end up with first syllable stress. However, this prediction remains untested because I could not find any examples in Loos' data in which both syllables are heavy.

(b) Spread H rightward within the foot:

```
 * H                        * H
 |/   \                     |/
(σ      σ)              (σ    σ)     σ              σ
/|\    /|               /|   /|\    /|             /|\
| μ μ | μ               | μ | μ μ | μ              | μ μ
| | | | |               | | | | | | |              | | |
č o s k o   čóskó       y o s a n b o   yosánbo    ? i n    ?ín   *?ín
```

To summarize the foregoing analysis of Capanahua, Weight-to-Stress applies non-iteratively (i.e., once per word) within the foot domain just as it does in Yidin^y. A H-tone is then assigned to the stressed syllable and spreads rightward. Notice, however, that the domain of tonal spreading in Capanahua is the foot; I return to this point in section 6.2.

Thus, the non-iterative application of Weight-to-Stress within the foot is observed in at least one other language (Capanahua) besides Yidin^y. Returning now to Yidin^y, the following sequence of events accounts for the penultimate length and stress in words like *gudá:ga*. (i) Syllabic feet are constructed iteratively from left to right; (ii) penultimate vowel lengthening is triggered by the presence of an unfooted final syllable; (iii) stress is inserted and linked to the rightmost footed heavy syllable; and (iv) stress is inserted and linked in each remaining foot. The linking of stress is from left to right by default, but this direction is overruled by the Uniform Linking Constraint in any word in which the prior application of Weight-to-Stress has created a right-stressed foot.

The default left-to-right linking of the stress autosegment is illustrated in (16).

(16) Input:

```
 σ   σ    σ   σ
/|  /|   /|  /|
ŋ u n a ŋg a r a
```

Build Feet:

```
(σ   σ)  (σ   σ)
/|  /|   /|  /|
ŋ u n a ŋg a r a
```

Weight-to-Stress:

N/A

Insert & Link *:

```
 *        *
 |        |
(σ   σ)  (σ   σ)
/|  /|   /|  /|
ŋ u n a ŋg a r a
```

Output:

ŋúnaŋgára

Although the stressing of odd-numbered syllables occurs only in words containing an even number of syllables, the converse is not true. That is, the fact that a word contains an even number of syllables does not entail that stress will fall on odd-numbered syllables. In particular, if a word with an even number of syllables contains one or more underlyingly long vowels, the Weight-to-Stress Principle will assign stress to the rightmost of these regardless of where it occurs. If that long vowel happens to be in an even-numbered syllable, the application of Weight-to-Stress will create a right-stressed foot, as illustrated in (17). The remaining foot has to become right-stressed as well because, as was already mentioned, the default left-to-right direction of linking is overridden if the derivation has already created a right-stressed foot. This was illustrated earlier for the case where Penultimate Lengthening has applied, but in (17) the vowel length is underlying rather than derived.

```
(17)  Input:                          Build Feet:                   Penult Length:

       σ   σ     σ   σ                (σ   σ)   (σ   σ)
      /|  /|\   /|  /|\               /|  /|\   /|  /|\
     | μ | μ μ | μ | μ μ             | μ | μ μ | μ | μ μ
     | | | |/  | | | | |             | | | |/  | | | | |
     y a dʸi   r i ŋ a l             y a dʸi   r i ŋ a l               N/A


      Weight to Stress:               Insert & Link *:              Output:

             *                                *         *
             |                                |         |
       (σ   σ)   (σ   σ)              (σ   σ)   (σ   σ)
       /|  /|\   /|  /|\              /|  /|\   /|  /|\
      | μ | μ μ | μ | μ μ            | μ | μ μ | μ | μ μ
      | | | |/  | | | | |            | | | |/  | | | | |
      y a dʸi   r i ŋ a l            y a dʸi   r i ŋ a l           yadʸí:riŋál
```

To summarize the above analysis of Yidin^y, syllabic feet are built iteratively from left to right. The direction of linking of the stress autosegment in these feet is determined later on the basis of the location of the rightmost foot-bound long vowel, if there is one, and vowel length can be either underlying or derived. If a word has no long vowels, then its feet are left-stressed by default. These processes are formalized below.

(18) Stress and Length in Yidin^y (Autosegmental Analysis):

(a) Build syllabic feet iteratively from left to right.

(b) Insert a mora into a syllable preceding an unfooted syllable.

(c) Apply Weight-to-Stress non-iteratively to a footed heavy syllable from right to left.

(d) Insert stress into each foot and link from left to right.

Several points are worth noting about the set of rules in (18). First, rules (a) and (b) are required for any account of Yidin^y stress,

regardless of its theoretical orientation. The exact wording of (a) and (b) will vary from one theory to another, of course, but such variation is going to be notational rather than substantive. Second, rule (c) is simply one of the possible ways (outlined in section 2.3.3.2) in which the Weight-to-Stress Principle may apply. What is particularly interesting in this case is that Yidin^y has independent evidence for a foot-building process which is itself insensitive to syllable weight even though the assignment of stress to feet is sensitive to syllable weight. This cannot be explained by a theory which does not separate stress from constituency.

Finally, rule (d) has the form of a typical autosegmental process. Notice, however, that the default direction of linking in this rule will be overruled if the result would violate the Uniform Linking Constraint. This may seem odd, but to the extent that the Uniform Linking Constraint is independently motivated, such behavior may be categorized as normal. Furthermore, the facts of reduplication provide independent evidence for the two directions of linking. Also, rule (d) has no effect on the stress pattern of a foot in which Weight-to-Stress has already applied, for the OCP blocks the linking of a second stress within the foot.

4.3. Other Analyses of Yidin^y Stress.

This section reviews and critiques three analyses of Yidin^y stress, arguing in each case that there are theoretical complications which are avoided by the autosegmental analysis of Yidin^y. I consider

first the proposal of Hayes 1982b, followed by Halle and Vergnaud 1987b and, finally, Hammond 1990b.

4.3.1. Hayes' 1982b Analysis.

Because of his assumption that feet are inherently headed, Hayes' 1982b analysis is necessarily more complex than mine. Hayes' proposal is as follows.

(19) Tree Construction: Going from left to right across the word, group syllables into binary feet, labelled w s.[11]

Following Tree Construction, Hayes applies Penultimate Lengthening, which has the effect of lengthening the penultimate syllable in a word with an odd number of syllables. Finally, he posits the following rule:[12]

(20) Stress Shift: Relabel all sister nodes s w, unless there is a strong node dominating a long vowel.

The application of Tree Construction, Penultimate Lengthening and Stress Shift is illustrated below.

---

[11]The terms *w* and *s* refer to *weak* (i.e., non-head) and *strong* (i.e., head), respectively. As Hayes himself points out, the labelling in this rule is not actually required by the data; all that matters at this point is the location of foot boundaries. Notice that such a syllabic foot (i.e., with the labelling [w s]) is prohibited under the theory of Hayes 1991, which requires all syllabic feet to be left-headed.

[12]Hayes also discusses other foot-bound rules which do not directly bear on the issue of separating stress and feet.

```
(21) Input:              Tree Constr:          Penult Length:

                             F                     F
                            / \                   / \
                           w   s                 w   s
     g u d a g a         g u d a g a           g u d a: g a

     Stress Shift:       Output:

        N/A              gudá:ga

(22) Input:              Tree Constr:          Penult Length:

                             F       F
                            / \     / \
                           w   s   w   s
     ŋ u n a ŋg a r a    ŋ u n a ŋg a r a         N/A

     Stress Shift:       Output:

         F      F
        / \    / \
       s   w  s   w
     ŋ u n a ŋg a r a    ŋúnaŋgára
```

Although Hayes' analysis produces the correct surface forms, it is suspect in that the rule of Stress Shift applies *globally*. Normally, rules of stress shift are *local*, i.e., they have a single trigger (typically another stress) which is adjacent to the stress that is being shifted.[13] In this case, however, Stress Shift applies throughout the word as though it were another foot-building rule, and yet Hayes does not formalize it as a foot-building rule. In contrast, the autosegmental analysis in the preceding section appealed to the Uniform Linking Constraint in order to override the default direction of linking in the

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[13]Indeed, it is widely held that all phonological rules must be local. See Howard 1972, Steriade 1987 and Archangeli and Pulleyblank 1987 and (in press).

same context where Hayes' rule of Stress Shift applies. Unlike Stress Shift, the autosegmental analysis is not subject to the charge of globality because the Uniform Linking Constraint is presumably innate, i.e., it holds in all languages. Consequently, it would not impose any burden on the language learner. Stress Shift, on the other hand, is a language-particular rule which must be learned.

In summary, Hayes' 1982b claim that feet have inherent heads forces him to posit a rule of Stress Shift which changes the headedness of all feet in the middle of the derivation just in case the dominant node of any foot branches. This rule should be rejected because, unlike most stress shift rules, it applies globally. The autosegmental analysis is able to avoid this problem precisely because it rejects Hayes' implicit claim that feet have inherent heads.

Next, I review the analysis of Yidin^y that is proposed in Halle and Vergnaud 1987b.

4.3.2. Halle and Vergnaud's 1987b Analysis.

As was mentioned in chapter 2, the possibility of headless metrical feet is built into the theory of Halle and Vergnaud 1987a and b. Even so, Halle and Vergnaud 1987b do not fully exploit this aspect of their theory in their analysis of Yidin^y stress. Rather than simply leaving feet headless (and, consequently, stressless) until after the application of Penultimate Lengthening, Halle and Vergnaud choose to construct two parallel metrical grids in every word. The feet in one of these grids are left-headed while the feet in the other grid are right-

headed. After Penultimate Lengthening has applied, one of these grids is deleted. This is formalized in (23) and illustrated in (24).[14]

(23) Yidin^y Stress and Length (Halle and Vergnaud 1987b):

(a) Line 0 parameter settings are [+BND, left to right], and right-headed on plane P1, left-headed on plane P2.
(b) Construct constituent boundaries on line 0.
(c) Locate the heads of line 0 constituents on line 1.
(d) Penultimate Lengthening.
(e) Delete P2 if on P1 there is a constituent head dominating a long vowel; otherwise delete P1.
(f) Delete a line 1 asterisk if it is directly preceded by a stress-bearing element with a line 1 asterisk.

```
(24)    Input:                Steps a-c:              Step d:

                                 *    *   *              *    *   *
   P1:  * * * * *             (* *)(* *)(*)           (* *)(* *)(*)
        gudagudaga            guda guda ga            guda guda:ga
   P2:  * * * * *             (* *)(* *)(*)           (* *)(* *)(*)
                               *    *    *             *    *    *

        Step e:               Step f:                 Output:

            *    *   *            *    *
   P1: (* *)(* *)(*)          (* *)(* *) *
        guda guda:ga          guda guda:ga            gudágudá:ga
```

As was observed regarding Hayes' analysis, Halle and Vergnaud's analysis contains some theoretical complications even though it derives the correct forms. Specifically, the above analysis builds two parallel metrical structures in every word, and yet each word ends up utilizing only one of those metrical structures. In other words, the grammar is forced to build twice as many feet as it actually needs. This require-

[14]Halle and Vergnaud discuss three other rules involving vowel length. Since these rules shed no further light on the points being made, I do not discuss them here.

ment follows only from the assumption that feet have to be assigned heads as soon as they are built. Ironically, Halle and Vergnaud do not cite any empirical basis for this assumption. On the contrary, as was mentioned earlier, their theory admits the possibility of headless feet.

As a further consequence of building two sets of feet, Halle and Vergnaud are forced to include rule (23e), which is *ad hoc*. To my knowledge, no such rule has been proposed elsewhere.

Notice that Halle and Vergnaud could avoid building feet on two separate planes simply by delaying the assignment of heads to feet until after Penultimate Lengthening has applied. This would be equivalent to what I proposed earlier, for the issue of whether or not feet can have heads is not relevant in this case.[15] Such an analysis would not be possible, however, in a theory such as that of Hayes 1991, where constituency and stress are truly inseparable.

Next, I consider Hammond's 1990b analysis of Yidin^y stress.

4.3.3. Hammond's 1990b Analysis.

The proposal in Hammond 1990b is similar in spirit to the one proposed in Hayes 1982b, but Hammond's rules are formalized in such a way

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[15]Actually, Halle and Vergnaud are forced to build both sets of feet because their formalization begins with a rule which assigns values to each of the foot parameters, including headedness. Because Halle and Vergnaud's arguments for doing this are entirely theory-internal, I do not repeat them here. The point to be noted is that only one rule of foot-building is required for Yidin^y if the assignment of heads (in my terms, *stress*) is delayed until after the application of Penultimate Lengthening.

as to allow the stress shift phenomenon to be explained in terms of universal principles rather than by stipulation.

Hammond's formalism is essentially the same as that of Hayes except as noted below. Hammond begins the derivation by building syllabic trochees from left to right. He then applies Penultimate Lengthening followed by a rule which accents a stressless long vowel; these rules are formalized below.

(25) <u>Hammond's 1990b Analysis of Yidin^y</u>:

(a) Build trochaic feet from left to right.[16]

(b) Penultimate Lengthening:

$$V \longrightarrow V: \;/\; \_\_\_\overset{*}{\overset{*}{\sigma}}]_{word}$$

(c) Accent a stressless long vowel:[17]

$$\overset{*}{V:} \longrightarrow \overset{\circ}{\overset{*}{V:}}$$

Hammond points out that rule (25b) is quite bizarre typologically in that it has the effect of lengthening a stressless vowel. But in fact this vowel surfaces with stress, and the stressing of long vowels is by no means uncommon cross-linguistically. What is strange in this case,

---

[16] Unlike Hayes 1991, Hammond allows degenerate feet to be built. Consequently, a word with an odd number of syllables will have a final degenerate foot, thus feeding Penultimate Lengthening.

[17] Following Hammond's 1989b conclusion that accent needs to be distinguishable from stress, Hammond 1990b uses a circle above the vowel to represent accent. This distinction is not crucial to the present discussion because, although Hammond uses different diacritics for accent and stress, he assumes that an accent will normally surface as stress. Also, for the sake of consistency I use asterisks in place of Hammond's x's.

however, is not that lengthening applies to some vowel, but rather that it applies *prior* to the assignment of stress to that vowel.

In order to account for the fact that the lengthening rule (25b) feeds the accenting rule (25c) rather than vice versa, Hammond appeals to the extragrammatical *Headship Prominence Principle*, which requires that the heads of metrical feet be at least as prominent as the other syllables of the string. Because of this principle, the application of the Accent Rule (25c) triggers global stress shift, not by rule but in order to satisfy two universal constraints, the *Uniform Headedness Constraint* (which is equivalent to the Uniform Linking Constraint; see section 2.3.3.4) and the *Monoheadedness Constraint*, which requires that each foot have only one head.[18] The application of these rules and principles is illustrated below. First, if a word has an even number of syllables and no even-numbered long vowels, then the environment for Penultimate Lengthening does not occur, and the feet surface as trochaic. This is illustrated in (26) and (27).

```
(26) Input:               Build Feet:            Output:

                           *
      *  *                (*  *)
     guygal               guygal                 gúygal

(27)                       *    *
      * * *   *           (* *)(*    *)
     wuŋaba:dʸiŋ          wuŋa ba:dʸiŋ           wúŋabá:dʸiŋ
```

[18] As Hammond points out, the Monoheadedness Constraint is a restatement of Halle and Vergnaud's 1987b Faithfulness Condition.

Notice that the long vowel in (27) is stressed by the foot-building rule, so the Accent rule does not apply.

If, on the other hand, a word has an even-numbered long vowel, either underlying as in (28) or through the application of Penultimate Lengthening as in (29), then the derivation proceeds as follows. First, trochaic feet are built and Penultimate Lengthening applies if the environment is met. Next, the Accent rule applies. Since this results in a foot with two stresses (violating the Monoheadedness Constraint), one of the two stresses has to be eliminated. In accordance with the Headship Prominence Principle, the accented long vowel keeps its stress and the unaccented (short) vowel loses its stress. This in turn automatically triggers stress shift in all the other feet of that word in order to satisfy the Uniform Headedness Constraint.

(28)	<u>Input</u>: * * * * yad^{y}i:ringal	<u>Build Feet</u>: * * (* *) (* *) yad^{y}i:ringal	<u>Penult Length</u>: N/A
	<u>Accent Rule</u> o * (* *) (* *) yad^{y}i:ringal	<u>Output</u>: *yad^{y}í:ringál*	
(29)	<u>Input</u>: * * * gudaga	<u>Build Feet</u>: * * (* *) (*) guda ga	<u>Penult Length</u>: * * (* *) (*) guda:ga

<u>Accent Rule</u> <u>Output</u>:

```
   o  *
(*  *)(*)
guda:ga                    gudá:ga[19]
```

The above proposal is very similar to that of Hayes 1982b, but it constitutes an improvement over Hayes' analysis in that Hammond appeals to the independently motivated Uniform Headedness Constraint, Monoheadedness Constraint and Headship Prominence Principle to motivate global stress shift in words whose rightmost long vowel is in an even syllable. Nevertheless, Hammond's account is subject to the following criticism. Since the feet of some words undergo a change in headship during the course of the derivation, it should be possible, in principle, for a rule to refer to the earlier headship. Since there is no evidence for the existence of such a rule, Hammond's analysis must be regarded as suspect.

In summary, Hammond's proposal is to be preferred over the proposals of Hayes and H&V in that Hammond utilizes only independently motivated principles in his analysis, whereas the others do not. Nevertheless, Hammond's analysis predicts that it should be possible for a rule to refer to a metrical head in a position which actually surfaces as stressless. The absence of evidence for such a rule argues against the existence of a derivational level at which metrical heads (or *stresses*, in my framework) are in positions other than the positions in which they surface.

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[19]Although Hammond 1990b makes no mention of it, I assume that he would eliminate the stress of a degenerate foot by rule.

4.4. Summary.

This chapter began by reviewing the basic facts of Yidin^y that were presented in chapter 2. Section 4.2 presented an autosegmental analysis, and section 4.3 reviewed the analyses of Hayes 1982b, Halle and Vergnaud 1987b and Hammond 1990b. It was argued that each of the previous analyses of Yidin^y stress raises theoretical problems which cannot be solved within the theoretical framework that was used.

For example, Hayes 1982b assumes that all feet have inherent heads. This assumption forces Hayes to posit a rule of Stress Shift which changes the headedness of all feet in the middle of the derivation just in case the dominant node of any foot branches. The problem with this analysis is that Stress Shift applies globally, thus imposing a generally unprecedented burden on the language learner.

The analysis of Halle and Vergnaud 1987b constructs two parallel metrical grids in every word. The feet in one of these grids are left-headed while the feet in the other grid are right-headed. After Penultimate Lengthening has applied, one of these grids is deleted. While this analysis derives the correct surface forms, it does so at the cost of building twice as much metrical structure as is actually utilized, later deleting the unneeded structure via an *ad hoc* rule.

Hammond's analysis constitutes an improvement over each of the above analyses. It is superior to Hayes' analysis in that Hammond appeals to the independently motivated Uniform Headedness Constraint (and other universal principles) as the motivation for global stress shift

rather than stipulating the stress shift via a language-particular rule. Hammond's proposal is also superior to that of Halle and Vergnaud in that it lacks the excessive machinery that is utilized by the latter. Nevertheless, Hammond's analysis of Yidin^y fails to capture the fact that there is no evidence for the existence of metrical heads (or stresses) prior to the application of Penultimate Lengthening. Indeed, the early introduction of metrical heads only complicates the analysis.

In contrast to the analyses that were proposed in Hayes 1982b, Halle and Vergnaud 1987b and Hammond 1990b, the autosegmental analysis does not entail any theoretical complications precisely because it assumes that feet are inherently headless. The latter assumption allows one to delay the assignment of stress until such time as its existence is actually attested by independent factors such as the phonetic features of stress or a phonological rule which refers directly to stress. This supports the claim that all feet, including those which surface with stress, are inherently headless. It also supports the closely related claim that stress and feet are formally separate.

The next chapter considers evidence from the stress patterns of Mayo and Tagalog which support the central claims of this study, both that stress is autosegmental and that foot-building must be kept separate from stress assignment.

CHAPTER 5

THE STABILITY OF ACCENT

The preceding chapters provided various kinds of evidence for the two central claims of the autosegmental theory of stress: (i) all feet are inherently headless and (ii) stress is an autosegment. Chapter 2 presented the arguments in favor of the first point as well as many of the arguments for the second point. In particular, it was argued that stress exhibits stability effects (Bedouin Hijazi Arabic), it can be morphemic (Spanish), it can consist of melodies (Malayalam, English) and it exhibits the kinds of mapping effects which may be expected of autosegments except for its failure to spread; the latter is discussed in section 6.2. Two other autosegmental properties were deferred for later discussion. These concern (i) the ability of autosegments to 'float', i.e., to exist on a plane by themselves without any link to individual segments, and (ii) polarity effects. This chapter instantiates the existence of these two properties in stress systems using data from Mayo, a Uto-Aztecan language of northwestern Mexico, and Tagalog, an Austronesian language of the Philippines.

Chapter 3 provided a brief argument for the claim that lexical accent floats in Mayo. The present chapter takes a closer look at Mayo's floating accent. Further evidence for the autosegmental nature of stress is deduced from base transfer effects in Mayo reduplication and from the interaction of segmental length and stress assignment in Mayo. In addition, it is argued that stress exhibits both the ability to float and polarity effects in Tagalog. The metrical theories of Halle and

Vergnaud 1987a and b (H&V) and Hayes 1991 are shown to be incapable of accounting for the autosegmental behavior of stress in these two languages. Together, these arguments lend further support to the autosegmental theory of stress that was proposed in chapter 2.

A major point of this chapter, then, is that stress can exhibit the same floating behavior that is a well-known characteristic of other autosegmental features such as tone, [ATR] and [NASAL]. That is, the existence of floating accent in languages such as Mayo and Tagalog constitutes a further argument for the claim that stress must be formally represented as an autosegment.

This chapter is organized as follows. Section 5.1 reviews the basic facts of Mayo stress that were presented in chapter 3. Looking only at words which lack vowel length, it is shown that the roots of all such words may be divided into two classes with respect to stress. In one class, stress always falls on the first syllable of the word regardless of how many prefixes it has, whereas second syllable stress is always observed in the other class of roots. An analysis is proposed in terms of the autosegmental theory of stress, claiming that certain Mayo words have a lexical accent which floats at certain points in the derivation just as tone floats in Mende, Etsako and Tiv. Further evidence for this analysis is provided from the facts of Mayo reduplication. Finally, it is argued that the theory of H&V is incapable of accounting for the basic facts of Mayo stress and reduplication.

Section 5.2 presents additional data on Mayo stress in words which contain long vowels (both derived and underlying) as well as in words

with derived consonant gemination. It is shown that the autosegmental theory of stress is able to account for the additional data in a straightforward manner, whereas neither H&V's theory nor Hayes' theory is capable of accounting for these additional data. It is also argued that an autosegmental stress is assigned directly to a footless word in certain environments, thus reinforcing chapter 2's claim that stress can exist apart from feet.

Section 5.3 demonstrates that Tagalog, like Mayo, has floating accent. However, the Tagalog stress window consists of the *rightmost* two syllables rather than the leftmost two syllables, as in Mayo. Applying the autosegmental theory of stress to the Tagalog data, two analyses are proposed. The first analysis builds a syllabic foot from right to left and later inserts and links a stress autosegment from left to right. In this view, Tagalog stress assignment is essentially the mirror image of Mayo stress assignment. The other analysis does not make use of foot-building. Rather, a rule of extrametricality applies to an unaccented word-final syllable and a stress autosegment is subsequently inserted and linked to the rightmost metrical stress-bearing unit. Under this analysis, Tagalog's nominal *-an* clitic exhibits polarity effects which are essentially parallel to those which were described for Margi's polarizing prefix in section 2.2.2. Each of these analyses of Tagalog utilizes only principles that are independently required in order to account for non-metrical phenomena in a variety of languages, but each analysis depends crucially upon the assumption that stress is an autosegment. In contrast, it is argued that the theories of H&V and Hayes

1991 are incapable of accounting for the stress pattern of Tagalog without resorting to *ad hoc* devices.

I begin by examining the evidence for the existence of floating accent in simple Mayo words, i.e., those which do not contain long vowels.

5.1. Floating Accent in Mayo.

This first section, which considers only words which lack vowel length, is organized as follows. Section 5.1.1 reviews chapter 3's analysis of the basic facts of Mayo stress, arguing that words with first syllable stress contain a lexical accent which is capable of floating at certain points in the derivation. Section 5.1.2 presents the facts of reduplication in Mayo. It is argued that (a) foot-building crucially has to precede and follow reduplication, (b) * Insertion and Linking is a non-cyclic rule and (c) lexical accent links and delinks cyclically. Finally, section 5.1.3 argues that the theory of H&V is incapable of accounting for these basic facts of Mayo stress and reduplication.

As in chapter 3, all of the Mayo data that are presented in this chapter are from my personal field notes which were collected in a number of villages of the Mayo River valley and Fuerte River valley between 1983 and 1990 under the auspices of the Summer Institute of Linguistics. Some of the data are additionally found in Collard and Collard 1962.

5.1.1. The Basic Stress Pattern of Mayo.

As chapter 3 mentioned, the presence of vowel length in certain words complicates the analysis of Mayo stress. Therefore, the discussion of vowel length is deferred until section 5.2, and the present section deals only with words having all short vowels. All such words have a single stress on either the first or second syllable; there is no secondary stress. The phonetic realization of stress, which is high pitch, is independent of its position in the word; i.e., first syllable stress is phonetically identical to second syllable stress.

The basic paradigm for Mayo stress is repeated below from chapter 3. The generalization is that every stem falls into one of two stress categories: It exhibits either first syllable stress, as in (1), (3), (5) and (7), or second syllable stress, as in (2), (4), (6) and (8).

	First Syllable Stress:			Second Syllable Stress:	
(1)	chúpnake	*will harvest (tran)*	(2)	ponnáke	*will play (tran)*
	híchupnake	*will harvest (intr)*		hipónnake	*will play (intr)*
	híhichupnake	*will always harvest*		hihíponnake	*will always play*
(3)	bwá'anake	*will eat (tran)*	(4)	ba'áte	*irrigate (tran)*
	hí'ibwanake	*will eat (intr)*		hibá'ate	*irrigate (intr)*
	híhi'ibwanake	*will always eat*		hihíba'ate	*always irrigate*
(5)	chíknake	*will sweep (tran)*	(6)	wiséka	*sawing (tran)*
	híchiknake	*will sweep (intr)*		hiwíseka	*sawing (intr)*
	híhichiknake	*will always sweep*		hihíwiseka	*always sawing*
(7)	ná'ikia	*count (tran)*	(8)	chiwéka	*shelling (tran)*
	hína'ikia	*count (intr)*		hichíweka	*shelling (intr)*
	híhina'ikia	*always count*		hihíchiweka	*always shelling*

Since the prefixes are the same in all eight of these sets of forms, it may be inferred that the stress category of a given stem remains constant under prefixation. That is, stress always occurs on the first syllable of words derived from certain stems, and it always occurs on the second syllable of words derived from certain other stems.

The data in (1) through (8) are representative of the entire Mayo language in that stress falls on either the first or second syllable of every word, and the lexicon seems to be fairly evenly divided between these two categories of stress. The distribution of coda consonants appears to have no bearing on stress placement; the stress pattern for a given stem remains constant even when the first syllable of the stem is 'closed', as in (1), (2) and (5). Since there is no way to predict which of the two stress patterns a particular word will have, one of these patterns must somehow be marked in the lexicon.

The challenge for any theory of stress, then, is to account for Mayo's two basic stress patterns in a uniform manner. Chapter 3 argued, on the basis of the prevalence of second syllable stress in loan words, that second syllable stress is the unmarked pattern in Mayo. This means that words with first syllable stress have to be lexically marked. As chapter 3 pointed out, there are two possible means of marking information about stress in the lexicon.[1] One of these is lexical extrametricality and the other is lexical accent. Extrametricality will not work

---

[1]A third logical possibility would be to use a pure diacritic instead of accent or extrametricality, as discussed in section 3.1.1.2. However, section 5.2 argues against this possibility on the basis of a correlation between stress patterns and lengthening patterns.

in this case because it cannot be used to derive first syllable stress. Therefore, it was concluded in chapter 3 that words with first syllable stress contain lexical accent.

The analysis that was proposed in chapter 3 is repeated in (9).

(9) <u>Mayo Stress Assignment</u>:

(a) Build a single syllabic foot from left to right.

(b) Insert * into the foot and link from right to left.

Applying this set of rules, the derivation of second syllable stress in an unaccented word is illustrated in (10).[2]

```
(10) Input:            Build 1 Foot:       Assign * to Σ:      Output:

                                                  *
                                                  |
      σ      σ   σ     (σ      σ)  σ       (σ      σ)  σ
     /|\    /|  /|     /|\    /|  /|       /|\    /|  /|
     p o n  n a k e    p o n  n a k e      p o n  n a k e      ponnáke
```

The derivation of stress in accented words would appear to be straightforward were it not for the additional facts to be presented in the next section. Before going on, however, consider how the two rules in (9) might apply to accented words. Section 3.1.1.2 demonstrated that the contrast between first and second syllable stress cannot be represented with an accent that is underlyingly associated to a particular stress-bearing unit. It was concluded, instead, that it must be the case that lexical accent is capable of floating at some stage of the

---

[2]Henceforth, I refer to words with lexical accent and words which lack lexical accent as *accented* and *unaccented*, respectively.

derivation. It may then link to the prefixed form from left to right via a rule. This is illustrated in (11).

(11) <u>Underlying</u>:   <u>Link</u>:

```
  *                            *
                               |
    σ      σ   σ               σ      σ   σ
   /|\    /|  /|              /|\    /|  /|
  chu p  n a  k e            chu p  n a  k e
```

Assuming, for the moment, that the regular foot-building rule in (9a) applies to accented words and that linking precedes foot-building, the OCP would prevent rule (9b) from applying, thus deriving the correct output as in (12).

(12) <u>Output of (11)</u>:   <u>Build Σ</u>:   <u>Insert/Link *</u>:   <u>Output</u>:

```
    *                     *
    |                     |
    σ      σ   σ         (σ      σ)  σ
   /|\    /|  /|         /|\    /|  /|
  chu p  n a  k e       chu p  n a  k e       Blocked by OCP     chúpnake
```

However, several questions remain to be addressed. First, assuming that the foot-building rule applies to accented words, does it apply before the accent links, or after (as shown above)? Also, does the accent link only once, after all prefixes have been added, or does it link (and delink) during each morphological cycle? These questions are addressed in the next section. There it is argued, on the basis of the facts of reduplication, that foot-building occurs after the accent links, and that foot-building, linking of the accent and delinking are all cyclic processes. It is also argued that the presence of a lexical accent

directly impacts the manner in which the foot-building rule is able to apply.

In summary, I have argued that the persistence of first syllable stress under prefixation of certain Mayo stems may be accounted for by assuming that these stems contain a lexical accent which is capable of floating. In contrast, the mobility of Mayo's accent cannot be explained at all if it is viewed merely as a prelinked feature. I return to this point in section 5.1.3, where H&V's theory is applied to the Mayo data. First, however, I describe the facts of reduplication in Mayo in order to settle the above questions regarding the interaction of lexical accent and foot-building.

5.1.2. Reduplication and Cyclic Stress.

The preceding section argued that Mayo words with first syllable stress have an accent which is capable of floating during the course of the derivation, and several questions were raised as to how this accent interacts with the process of foot-building. This section demonstrates that there are two distinct reduplicative bases in Mayo, and that the respective distributions of these bases correspond to the distributions of the two accentual classes that were described in the preceding section. Based on this distributional correspondence, it is argued that Mayo's lexical accent undergoes cyclic linking and delinking, forcing the rule of foot-building to construct a degenerate foot in each cycle. While this particular interpretation of the facts of Mayo is not crucial to the autosegmental theory of stress, it makes it possible to account

for all of Mayo's stress-related phenomena without resorting to anything but standard autosegmental rules and representations.

The arguments in this section depend crucially upon the facts of reduplication in Mayo verbs. Accordingly, before going into the finer details, I present a general description of Mayo reduplication and propose an analysis in terms of the theory of McCarthy and Prince 1986, 1990 (henceforth, M&P).[3]

In each of the following examples, the meaning of the verb is augmented with habitual aspect by copying the first syllable of the verb stem and prefixing it to the verb.[4]

(13)	yúke	*it's raining*	yúyuke	*it rains (often)*
(14)	tíwe	*feels shame*	títiwe	*is (always) ashamed*
(15)	noká	*speaks*	nonóka	*keeps speaking*
(16)	bwaná	*cries*	bwabwána	*keeps crying*

Notice that the stems in (13) and (14) are accented and the stems in (15) and (16) are unaccented. In each case, stress shifts one syllable to the left following prefixation so as to preserve the stem's inherent stress pattern, as was already pointed out in the preceding section.

M&P's model of reduplication consists of both a target and a base of reduplication. The target is an affix consisting only of a single

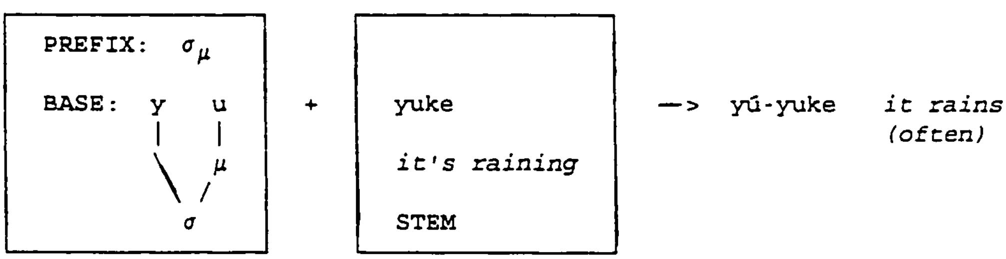
[3]Many of the issues concerning a theory of reduplication are not relevant to the theory of stress that is proposed here. For a thorough critique of M&P's model as well as an alternative to their model, see Spring 1990. The data presented here can be analyzed within Spring's theory without affecting my crucial point, which is that foot-building has to apply both before and after the process of reduplication.

[4]For ease of exposition, all of the examples in this section contain only short vowels. However, the conclusions are equally valid for words containing long vowels. The latter are discussed in section 5.2.

prosodic structure, such as a syllable or a foot, with no melodic content of its own. The base is that portion of the stem's melody which is made available for mapping to the target. The base may be prosodically defined, such as the first syllable or foot, or it may be morphologically defined, such as the entire stem. Thus, reduplication is a universal device whereby a stem (or portion thereof) provides the segmental content for some affix whose underlying representation consists only of a prosodic skeleton.

Using this model, a schematic derivation of *yúyuke* is given in (17). In this case, an empty monomoraic syllable is the prefix (i.e., target), and the stem is an accented word.[5] Notice that there is a directional, one-to-one mapping between the prefix and the base (which consists of at least the first syllable of the stem), just like the mapping that takes place between any sequence of autosegments and the potential bearers of those autosegments.

(17)



[5]M&P's Template Satisfaction Condition requires that every template be completely satisfied. Since the target is a template, the prosodic form of the prefix in the output tells us exactly what the target consists of. Thus, in this example, the target has to be a monomoraic syllable.

There are actually three reduplicative morphemes in Mayo, but one of these (described in Hagberg 1989c) is not relevant to the present discussion. Both of Mayo's remaining reduplicative morphemes are prefixes, and both are applicable to nearly all verbs and adjectives regardless of stress category. (Most exceptions may be attributed to semantic considerations). One of these prefixes is an empty monomoraic syllable and the other is an empty bimoraic syllable. Escalante 1990 demonstrates that these two prefixes have different meanings in the closely related language, Yaqui. In Mayo, however, the semantic distinction between these two reduplicative prefixes has been all but lost. A few older speakers attribute different meanings to the two reduplicative prefixes, but this distinction seems to be lacking for virtually all younger speakers. For the latter, both prefixes carry the general meaning of habitual or repetitive (and sometimes distributive or iterative) aspect, and many speakers seem to vary freely in their use of the two prefixes. Thus, the semantic distinction between these two prefixes is not relevant to the present study. All that matters here is the phonological form of each prefix and its interaction with the base of reduplication. Consequently, I do not attempt to distinguish the respective meanings of the two prefixes in the glosses that are provided.

In what follows I show that the prosodic form of the base, from which the reduplicative prefixes receive their melodic content, is always determined by the stress class of the stem. Specifically, it is argued that the base of an accented stem is limited to the first syllable, but that the base of an unaccented stem has to include more than

just the first syllable of the stem. In order to account for these apparently disjoint facts in a uniform manner, it is concluded that the unit corresponding to the base (for both types of stems) is prosodic, not morphological, and that it consists of the foot.

This conclusion is possible, of course, only if the foot in accented words is degenerate. In keeping with the analysis given in the preceding section, the former option is selected; i.e., it is concluded that feet are always degenerate in accented words.

In order to argue for these conclusions, I examine the effects of reduplication first with accented stems and then with unaccented stems.

5.1.2.1. Reduplication in Accented Stems.

This section examines the alternations that occur with respect to reduplication in accented stems, arguing that the first syllable functions as the base of reduplication in each case.

Recall that the reduplication process copied only the first syllable in (13) through (16), and notice that the copied syllable was monomoraic. This means that each of these examples utilizes the monomoraic reduplicative prefix, which copies the onset and first mora of the first syllable regardless of whether the stem is accented or unaccented. (Recall that there are two reduplicative prefixes in Mayo; one is monomoraic and the other, which has not yet been illustrated, is bimoraic).

Now consider what happens when the first syllable of an accented stem is bimoraic. Each of the stems in (18) through (22) is accented, and each happens to begin with a closed syllable. The free variation in

each of the habitual forms is due to the fact that there are actually two different target prefixes. The monomoraic prefix copies only the first onset-vowel sequence of the stem, while the bimoraic prefix copies the entire first syllable, including the coda.

Initial Syllable is Bimoraic:

	Stem:	Prefix = σ_{μ}	~	Prefix = $\sigma_{\mu\mu}$	Gloss:
(18)	nókwa	nó-nokwa	~	nók-nokwa	known language
(19)	tíwnake	tí-tiwnake	~	tíw-tiwnake	will be ashamed
(20)	wómte	wó-womte	~	wóm-womte	be frightened
(21)	búyte	bú-buyte	~	búy-buyte	run (SG)
(22)	wáttiawa	wá-wattiawa	~	wát-wattiawa	put (collective)

For each of the stems in (18) through (22), the size of the prefix is less than or equal to the size of the initial syllable of the stem. Since the larger of the two reduplicative prefixes is able to copy the initial syllable in its entirety, it must be the case that the reduplicative base consists of at least the entire first syllable of the stem. But can the reduplicative base be larger than a syllable?

In order to answer this question, consider the forms that result when the prefix is larger than the first syllable of the stem. This situation is exemplified in (23) through (27), where each of the stems is again accented, but in this case each stem begins with a monomoraic syllable. If if should be the case that the reduplicative base is limited to of the first syllable of the stem, then it would follow that the base in each of these examples is monomoraic. For each stem, consequently, the monomoraic prefix would be expected to achieve a one-to-one

mapping with the base, but the bimoraic prefix would still have one mora waiting to be filled after it has exhausted the base.

Initial Syllable is Monomoraic:

	Stem:	Prefix = σ_{μ}	~	Prefix = $\sigma_{\mu\mu}$	Unattested:	Gloss:
(23)	nóka	nó-noka	~	nón-noka	*nók-noka	know language
(24)	tíwe	tí-tiwe	~	tít-tiwe	*tíw-tiwe	be ashamed
(25)	chíke	chí-chike	~	chít-chike	*chík-chike	comb
(26)	híma	hí-hima	~	híh-hima	*hím-hima	throw
(27)	yúke	yú-yuke	~	yúy-yuke	*yúk-yuke	rain

Notice, from the 'Unattested' forms, that the bimoraic prefix fails to copy anything beyond the first syllable of the stem. Rather, I conclude that the bimoraic prefix's 'stranded' mora obtains its melody from the initial segment of the stem via Leftward Spread (28):

(28) Leftward Spread: Spread the root node leftward to an unassociated mora.[6]

```
(29)        μ          —>    μ
                              \
               R               R
```

The application of Leftward Spread to (23) is illustrated in (30).

```
(30)              PREFIX:      σ
                              /|\
                             | μ μ   STEM:
                             | |   \
                  BASE:      n o    n o k a        nón-noka
```

[6]There are constraints which prohibit certain segments from being moraic (see Hagberg 1990), but these constraints are independent of Leftward Spread and so are not stated in the rule. Whenever Leftward Spread is thus blocked, the direction of spread is rightward, i.e., the vowel lengthens. This is described and illustrated in section 5.2.

This rule follows from the assumption that the mora is part of the reduplicative target, which is a template. All elements of a template must be satisfied in order to exist in the representation, and Leftward Spread is one of the mechanisms available to grammars by which template satisfaction may be achieved. (The other two possibilities are rightward spread and epenthesis. The former is instantiated in section 5.2.1; Mayo's use of the latter is discussed in Hagberg 1990).

To summarize thus far, the rule of Leftward Spread means that a root node spreads leftward to a mora that is not already associated to a root node. The environment for Leftward Spread is created whenever the reduplicative target is larger than the reduplicative base, which has been argued to consist of the first syllable of the stem in the case of accented words. Another means of creating this same environment is discussed in section 5.2.

A comparison of the unattested forms in (23) through (27) with their attested counterparts in (18) through (22) (repeated below as 31 through 35) makes it clear that the base of each of these stems consists of only the first syllable. If the base were assumed to consist of *more* than the first syllable, then there would be no way to explain, for example, why *nók-nok-wa* is attested but **nók-nok-a* is unattested. The difference cannot be attributed to morphology, for the root *nók* is the same in each case.

	<u>Stem</u>:	<u>Prefix</u> = σ_{μ}	~ <u>Prefix</u> = $\sigma_{\mu\mu}$	<u>Unattested</u>:	<u>Gloss</u>:
(31)	nókwa	nó-nokwa	~ nók-nokwa	*nón-nokwa	known language
(32)	tíwnake	tí-tiwnake	~ tíw-tiwnake	*tít-tiwnake	will be ashamed
(33)	wómte	wó-womte	~ wóm-womte	*wów-womte	be frightened

(34) búyte	bú-buyte	˜ búy-buyte	*búb-buyte	run (SG)
(35) wáttiawa	wá-wattiawa	˜ wát-wattiawa	*wáw-wattiawa	put (collect.)

Furthermore, spreading is unattested in (31) through (35). This is precisely because the base (i.e., the first syllable) of each of these stems is bimoraic, so the bimoraic prefix will be exhausted when it is applied to the base. This is illustrated in (36).

(36)

			<u>Prefix</u>: σ_{μ}		<u>Prefix</u>: $\sigma_{\mu\mu}$	
Base = $\sigma_{\mu\mu}$	<u>nók</u>wa	—>	<u>nó</u>-nokwa	˜	<u>nók</u>-nokwa	—> Spreading <u>cannot</u> apply.

Thus far, I have demonstrated that the reduplicative base for stems with lexical accent is the first syllable. Spreading applies whenever the prefix cannot obtain all of its melody from the base, as in (37). Spreading cannot apply, however, whenever the base is as large as the prefix, as in (36).

(37)

			<u>Prefix</u>: σ_{μ}		<u>Prefix</u>: $\sigma_{\mu\mu}$	
Base = σ_{μ}	<u>nó</u>ka	—>	<u>nó</u>-noka	˜	<u>nó( )</u>-noka	—> Spreading <u>can</u> apply.

Next, I examine reduplication in unaccented stems. It is demonstrated that, unlike accented stems, the base of reduplication in unaccented stems consists of *more than* the first syllable of the stem.

5.1.2.2. Reduplication in Unaccented Stems.

Many reduplicated unaccented forms exhibit the same patterns as were observed for accented stems in the preceding section. For example,

whenever the first syllable of an unaccented stem is closed, spreading is unattested, just as was shown for accented stems. This is illustrated in (38) through (41).

	Prefix = σ_{μ}	~	Prefix = $\sigma_{\mu\mu}$	Unattested:	Gloss:
(38)	bwa-bwánnake	~	bwan-bwánnake	*bwab-bwánnake	will cry
(39)	bwi-bwíknake	~	bwik-bwíknake	*bwib-bwíknake	will sing
(40)	no-nóknake	~	nok-nóknake	*non-nóknake	will speak
(41)	o-'ómte	~	om-ómte	*o'-'ómte	hates

But it turns out that more than the first syllable is available for copying in unaccented stems. Consider the forms in (42) through (45): Each of these stems must be unaccented because stress always occurs on the second syllable.[7] Furthermore, each stem begins with a monomoraic syllable. Nevertheless, in every case the bimoraic prefix copies the first three segments of the stem in spite of the fact that these three segments are not tautosyllabic. This indicates that the base of unaccented stems, unlike that of accented stems, must consist of more than just the first syllable of the stem.

	Prefix = σ_{μ}	~	Prefix = $\sigma_{\mu\mu}$	Unattested:	Gloss:
(42)	no-nóka	~	nok-nóka	*non-nóka	speak
(43)	bwa-bwána	~	bwan-bwána	*bwab-bwána	cry
(44)	si-síme	~	sim-síme	*sis-síme	go (SG)
(45)	bwi-bwíka	~	bwik-bwíka	*bwib-bwíka	sing

[7]At first glance the stem in (42) might appear to be the same as that of (37) *(nóka)*, but these stems differ in two ways. First, the stem of (42) *(noká)* differs phonologically from the stem of (37) *(nóka)* in its accentual status, and second, these two stems have different meanings. I conclude, therefore, that they are (synchronically) derivationally unrelated.

The absence of gemination in the above forms cannot be attributed to some general proscription against second syllable stress when preceded by a geminate, for there are (synchronically) monomorphemic forms such as *ettého* 'discuss, converse' and *bannári* 'atole' which exhibit such a pattern.

Now compare (46) with (23), repeated below as (47). Notice that the forms are identical, except for the location of stress, when the monomoraic prefix is applied, but their melodic content is different after the bimoraic prefix has been applied. The difference is that the reduplication process has copied more than the first syllable of the unaccented stem (46), whereas only the first syllable gets copied from the accented stem (47).

(46)	Unaccented Stem:				Base of
	no-nóka ~ nok-nóka	*non-nóka	*speak*		Stem: [noka]
(47)	Accented Stem:				Base of
	nó-noka ~ nón-noka	*nók-noka	*know language*		Stem: [no]

The asymmetry between nok-nóka in (46) and nón-noka in (47) poses an interesting problem for prosodic theory for the following reason: The only way to account for this asymmetry is to assume that the reduplicative base of accented words is fundamentally different from that of unaccented words. Specifically, the base of accented words must be limited to the first syllable of the stem, whereas the base of unaccented words must be large enough to include not only the first syllable but also at least the first segment of the following syllable of the stem.

However, it would be incorrect to stipulate that reduplicative prefixation copies the first syllable for words with first syllable stress, and that it copies the first three segments for words with second syllable stress. Such counting ability is clearly to be rejected as too powerful a device for phonological processes, as argued in Halle and Vergnaud 1987b and McCarthy and Prince 1990. Indeed, M&P's theory requires that a single prosodic unit be utilized as the base of any given reduplication process. Consequently, some means must be found for expressing the monosyllabic base of accented words and the longer base of unaccented words in terms of a single prosodic entity.

The identity of the prosodic unit that serves as the reduplicative base in Mayo may be deduced via the following line of reasoning. Since the base in unaccented words has to include at least one more segment beyond the first syllable, the smallest possible unit for the base is the foot; there is no smaller prosodic entity which is larger than the syllable. Thus, the reduplicative base must consist either of the foot or of some higher-level prosodic structure. Furthermore, since the base in accented stems never extends beyond the first syllable and since it is necessary to express the base for all stems (accented and unaccented) in terms of a single prosodic entity, I conclude that the smallest possible base for unaccented words (the foot) is also the base for accented words.

Given this conclusion, there are two possible explanations for the fact that the base appears to be limited to the first syllable in accented words such as *nóka* and *chíke*. One possibility is that, even

though the grammar specifies the foot as the base of reduplication, foot-building never occurs in accented words. If this were the case, then the reduplication process would presumably be forced to utilize some other prosodic unit as the base, and one might surmise that the syllable is elected as the default base in footless words. However, this analysis is suspect in light of the fact, reported in Moravcsik 1978 and McCarthy and Prince 1990, that a large amount of descriptive research has failed to turn up a reduplicative process that unambiguously copies a single syllable. As McCarthy and Prince explain, the total absence of such a process indicates that universal grammar does not include the syllable as one of the units which may be utilized as a reduplicative base. This conclusion about universal grammar argues against the possibility that accented words are footless and that the syllable is selected as the default reduplicative base.

The only other possibility, which I therefore assume to be correct, is that the foot is degenerate in accented words. Consequently, an accented word has a monosyllabic foot while an unaccented word has a disyllabic foot, as illustrated below.

(48) <u>Accented</u>: <u>Unaccented</u>:

```
 *                                *
 |                                |
(σ)  σ                          (σ   σ)
/|  /|                          /|  /|
n o k a    know language        n o k a    speak
```

This explains the apparent difference between the reduplicative bases of accented and unaccented words. Furthermore, in what follows I argue

that the admission of degenerate feet is the only way to accomodate all of the facts of Mayo without introducing more radical innovations into metrical and autosegmental theory.

As was discussed in section 1.2.3, I follow Kiparsky 1973, 1979, 1982, 1985, Mohanan 1982, 1986 and Halle and Vergnaud 1987a and b in assuming that each morphological operation triggers the application of a set of phonological rules.[8] Furthermore, I assume the Strong Domain Hypothesis (Myers 1991b; see also the aforementioned references), which asserts that (i) if a phonological rule is available at one point in the derivation, then it is also available at all earlier stages of the derivation, and (ii) a grammar may permanently 'turn off' a phonological rule at any point in the derivation.

Applying these basic assumptions to the Mayo data, I propose the following analysis. First, the floating autosegment of accented words links by rule from left to right at the beginning of a cycle (i.e., immediately following any morphological operation).[9] This same accent undergoes a language-particular delinking rule at some later point in the cycle. The linking rule never gets turned off (i.e., it is both lexical and postlexical), but the delinking rule is turned off at the end of the lexical phase of the phonology, i.e., after all word-level

[8]As section 1.2.3 mentioned, since all Mayo affixes appear to be cyclic, I do not address the formal distinction between cyclic and noncyclic morphemes that appears to be operative in some other languages such as Russian and Sanskrit (Halle and Vergnaud 1987a and b).

[9]It does not seem possible to tell whether or not the accent is linked in underlying representation. If it is underlyingly linked, then it has to delink prior to any prefixation in order to account for the fact that it moves to the prefix.

morphological processes have applied. Thus, a lexical accent links to the leftmost stress-bearing unit at the beginning of a cycle and delinks near the end of that cycle, making it available to link to the leftmost stress-bearing unit following the next prefixation. At the end of the final morphological cycle the accent again delinks, but it relinks to the same place during the postlexical phase.

Having proposed that a lexical accent links to the leftmost stress-bearing unit at the beginning of each cycle, and in order to provide a uniform explanation for the facts of Mayo stress and reduplication that were presented earlier, I next invoke the Degenerate Foot Principle. This principle, which was presented in section 2.3.3.3, states that the presence of a stress autosegment linked to any element that is being incorporated into a foot forces that foot to become degenerate, as illustrated below.

```
(49)     *                *              *
         |                |              |
      n o k a   -->  (n o) k a    * (n o k a)
```

The Degenerate Foot Principle may be viewed as a special case of H&V's Faithfulness Condition, which requires that metrical constituents be constructed in such a way that a lexically stressed syllable will always be a constituent head. Of course, since my theory does not admit metrical heads, the Faithfulness Condition technically cannot be invoked in the form in which H&V present it. However, it seems that the actual intent of the Faithfulness Condition is to acknowledge the fact that lexical accent is stable, i.e., it generally overrides rules of stress

placement. This central aspect of the Faithfulness Condition is orthogonal to the question of whether or not metrical heads exist, and it is this feature of accentual stability which I am invoking as an argument for the Degenerate Foot Principle; the argument is as follows. Section 3.1.1.2 demonstrated that the unmarked surface stress pattern in Mayo consists of a single right-stressed foot on the left edge of the word. Based on this conclusion, it follows from the characteristic stability of lexical accent (as expressed by the Faithfulness Condition) that the presence of lexical accent on the first stress-bearing unit should force the foot-building process to create a degenerate foot so as to conform to the right-sided relationship between stress and foot structure in unaccented words.

The motivation for the Degenerate Foot Principle follows from the foregoing conclusion that the base of reduplication consists of a disyllabic foot for unaccented words and a single syllable for accented words. In order to treat both accentual classes in a uniform manner, it is necessary to assume that accented words have a degenerate (i.e., monosyllabic) foot at the point in the derivation where reduplication takes place.

But there are only two possible means of deriving such a degenerate foot. One way would be to assume that a floating accent remains floating until the very end of the derivation. The advantage of this approach would be that it would not need the cyclic linking and delinking rules that are proposed below. However, this analysis entails stipulating that a degenerate foot is built whenever a floating stress au-

tosegment is 'present' (but not linked) in the derivation. Since such a stipulation is unprecedented in phonological theory, I reject this approach to deriving a degenerate foot.

The only alternative means of deriving a degenerate foot in accented words makes use of a modified version of H&V's concept of *Stress Copy*. The basic idea of Stress Copy is that, although information about stress is normally not carried over from one morphological cycle to the next, a grammar may nevertheless choose to do this via a rule. Halle and Vergnaud 1987a and b argue that such a rule is needed in order to account for the stress patterns of Damascene Arabic and Russian.

Recall that a Mayo word's accentual status (i.e., the property of being either accented or unaccented) remains constant in going from one morphological cycle to the next. This is evidenced by the fact that the presence or absence of lexical accent determines the final output of stress assignment regardless of how many morphological cycles are included in the derivation. Consequently, Mayo requires some kind of Stress Copy rule regardless of whether or not the Degenerate Foot Principle is adopted.

However, unlike the accents found in Damascene Arabic and Russian, which are linked to particular stress-bearing units throughout the derivation, Mayo's lexical accent cannot remain linked to just one stress-bearing unit throughout the derivation. It must either remain floating until after the final morphological process has applied, or else it must link to the leftmost stress-bearing unit at the beginning of each cycle and delink at the end of each cycle.

If the former option is chosen, i.e., if lexical accent is considered to remain floating until just before the end of the derivation, then one of the following two theoretical innovations is required. Either it must be stipulated that the 'presence' of a floating accent in a representation interacts with the foot-building process in such a way as to create a degenerate foot, or else it must be stipulated that Mayo has a rule which copies a floating accent from one cyclic plane to another without affecting its floating status. Since each of these stipulations constitutes an otherwise-unmotivated enrichment of metrical theory, I conclude that lexical accent does *not* remain floating throughout the derivation. Instead, I assume that a lexical accent always links by rule to the leftmost stress-bearing unit at the beginning of a cycle and delinks at (or near) the end of that cycle. This is illustrated below.

```
(50) Underlying:          Link:               Build Foot:

     *                     *                    *
                           |                    |
     chupnake             chupnake             (chup)nake


     Delink:              Add Prefix:          Link:

        *                      *               *
                                               |
      (chup)nake          hi-chupnake          hichupnake


     Build Foot:          Delink:

       *                    *
       |
      (hi)chupnake         (hi)chupnake
```

At some late point in the derivation, presumably during the postlexical stage, the rule of delinking is 'turned off', allowing an accent to link to the leftmost stress-bearing unit and remain there, as shown below.

(51) <u>Link</u>:   <u>Output</u>:

```
      *
      |
   (hi)chupnake            híchupnake
```

Notice that foot-building, like the other rules, is cyclic in the above derivation. This must be the case because reduplication can take place at more than one point in the derivation (e.g., *bwá-'bwanake* and *hí-hi-'bwanake* are both attested). Since base transfer can occur at either of these points in accented words (e.g., *bwáb-bwa'nake* and *híh-hi-'bwanake*) but never in unaccented words, it is necessary for the previous cycle's footing to be erased and a new foot constructed in each new cycle.

The foregoing analysis entails that the regular rule of stress insertion and linking, which derives stress in unaccented words as shown below, must be strictly non-cyclic (i.e., postlexical).

(52) <u>Input</u>:   <u>Assign * to Σ</u>:   <u>Output</u>:

```
                                        *
                                        |
   (σ     σ)  σ                  (σ     σ)  σ
   /|\    /|  /|                 /|\    /|  /|
   p o n n a k e                 p o n n a k e               ponnáke
```

If stress insertion were to apply cyclically, then the cyclic rule of delinking would apply in unaccented words, resulting in neutralization

of the contrast between accented and unaccented words. This is illustrated below.

(53) <u>Input</u>:   <u>Delink</u>:   <u>Add Prefix</u>:

```
         *                        *                             *
         |
  (σ     σ)  σ          (σ     σ)  σ              σ   σ     σ   σ
  /|\   /|  /|          /|\   /|  /|             /|  /|\   /|  /|
  p o n n a k e         p o n n a k e            h i-p o n n a k e
```

<u>Link</u>:   <u>Build Foot</u>:   <u>Assign * to Σ</u>:

```
   *                      *
   |                      |
   σ   σ     σ   σ       (σ)  σ     σ   σ
  /|  /|\   /|  /|       /|  /|\   /|  /|
  h i p o n n a k e      h i p o n n a k e      Blocked by OCP
```

<u>Output</u>:

* *híponnake* (Should be *hipónnake)*

If, on the other hand, the regular rule of stress insertion and linking is strictly postlexical, then Delinking will get turned off prior to the application of regular stress assignment, and the accentual contrast is preserved. I conclude, therefore, that this is the case.

The above analysis is arguably more complex, in terms of the number of phonological operations in a derivation, than either of the alternatives which assume that lexical accent remains floating throughout most of the derivation. Nevertheless, the cyclic delinking/relinking analysis is to be preferred over the other two possible analyses in that it alone requires no theoretical innovation. In other words, cyclic rules of delinking and linking are attested in other languages such as

Yoruba and Margi (Pulleyblank 1986) as well as Japanese (Ishihara 1991), whereas there is no cross-linguistic motivation for any kind of direct interaction between a floating autosegment and a foot-building process.

As section 2.3.3.3 pointed out, the Degenerate Foot Principle does *not* entail any claim regarding what might happen to previously-constructed feet when autosegmental stresses are assigned to them. Rather, the Degenerate Foot Principle claims only that a linked stress autosegment affects the *process* of foot-building, just as certain segmental features may directly influence the process of syllabification.

In summary, given that Mayo's reduplicative base must be expressed as a single prosodic unit, there is only one possible conclusion: It must be the case that the foot is the base of reduplication. This conclusion is valid only if it is assumed that the foot is monosyllabic in accented words, and the latter assumption entails the claim that lexical accent undergoes cyclic and non-cyclic (i.e., postlexical) linking as well as cyclic delinking. The next section presents an overview of the analysis of Mayo reduplication in terms of these conclusions.

5.1.2.3. A Summary of Reduplication.

Based upon the conclusions of the preceding two sections, the analysis of Mayo reduplication is summarized below in chart form.

		TARGET		
		Monomoraic	Bimoraic	Unattested
(54)	Accented * Stem = nokwa Base = [nok]	μ | n o k nokwa [nónokwa]	μ μ | | n o k nokwa [nóknokwa]	*[nónnokwa]
(55)	Accented * Stem = noka Base = [no]	μ | n o noka [nónoka]	μ μ | \\ n o noka [nónnoka]	*[nóknoka]
(56)	Unaccented Stem = noka Base = [noka]	μ | n o k a noka [nonóka]	μ μ | | n o k a noka [noknóka]	*[nonnóka]

The monomoraic prefix takes the same form in each example, but this is not observed with the bimoraic prefix. The accented stem in (54) begins with a bimoraic syllable, so the bimoraic prefix is completely satisfied by the base. In contrast, the accented stem in (55) begins with a monomoraic syllable, so spreading applies to fill the second mora of the bimoraic prefix. The stem in (56) is unaccented, so the base is long enough to completely satisfy the bimoraic prefix even though the first syllable is monomoraic.

To summarize the point of all the reduplication data, the reduplicative base for Mayo is the foot, but this foot is somewhat unusual in that it consists of only one syllable in the case of accented words.

One further point needs to be made regarding the interaction of foot-building and reduplication. Since the foot is the reduplicative base, the rule of foot-building has to precede reduplication. However, it is also necessary for foot-building to *follow* reduplication, just as

it was argued that foot-building must occur in other morphological cycles. This can be seen by examining the pair of forms in (57). Since the reduplicated prefix in *nok-nóka* has copied more than the first syllable of the stem, it must be the case that the reduplicative base is the foot. However, the actual foot structure of *noká* is not carried over to *noknóka*, for stress occurs on a different vowel in *noknóka* than in *noká*. Consequently, it must be the case that foot-building reapplies following reduplication.

(57) noká *speak* nok-nóka *keep speaking*

This conclusion has interesting implications regarding the behavior of Mayo's autosegmental accent. In order to maintain an analysis that applies the reduplication process to accented and unaccented words in a consistent manner, it must be assumed that (i) the presence of a stress autosegment linked to any element that is being incorporated into a foot forces that foot to become degenerate, and (ii) lexical accent undergoes cyclic and non-cyclic linking as well as cyclic delinking. The latter claim was argued for earlier on the basis of the cyclic perseverance of first syllable stress in accented words. However, the parallel cyclic perseverance of the distinction between the reduplication patterns of accented and unaccented words constitutes an additional argument for the cyclic linking/delinking analysis. This is because a lexical accent has to be linked to the leftmost vowel prior to the application of reduplication, but the accent cannot remain there after reduplication applies.

The next section uses the facts of Mayo reduplication to argue against the theory of H&V. In particular, it is shown that H&V's theory must be enriched in order to account for the contrast between first and second syllable stress while simultaneously accounting for the cyclic application of foot-building. In contrast, the autosegmental theory of stress has been shown to be capable of handling these facts in a straightforward manner.

5.1.3. A Problem for the Theory of Halle and Vergnaud.

This section considers the question of how one might account for the Mayo data of the preceding sections utilizing the theory of H&V. It is argued that, although many of the basic stress facts may be accounted for under H&V's theory, it is nevertheless impossible for H&V's theory to generate the correct stress patterns when the cyclic nature of stress assignment, which is required by the facts of reduplication, is taken into account.

Recall that each of the loan words from Spanish that were cited in chapter 3 ended up with second syllable stress in the Mayo form. This was the basis for claiming that second syllable stress is unmarked in Mayo, i.e., that second syllable stress may be derived without the use of lexical accent or lexical extrametricality. This means, in terms of H&V's theory as well as my theory, that first syllable stress must be attributed to the presence of either lexical accent or lexical extrametricality. But since the very nature of extrametricality prevents it

from being used to account for first syllable stress, it was concluded that lexical accent is the source of first syllable stress.

Assuming, then, that second syllable stress is the unmarked case for Mayo words, how might this stress pattern be derived using the theory of H&V? At first glance there is more than one possible set of rules. One such set is presented in (58), and a sample derivation for an unaccented word is given in (59). The feature of (58) which crucially distinguishes it from other possible analyses is that the feet in (58) are bounded, which means they are maximally binary.

(58) <u>Mayo Stress Assignment (Using H&V's theory)</u>:

(a) Construct bounded right-headed feet from left to right.
(b) Construct an unbounded left-headed word tree.
(c) Conflate lines 1 and 2.

(59) <u>Input</u>: <u>Step (a)</u>: <u>Step (b)</u>:

```
                                                    *          line 2
                      *        *                  (*         *)  line 1
 *   *    *   *     (*   *)  (*   *)     (*   *)  (*   *)  line 0
h i p o n n a k e   h i p o n n a k e   h i p o n n a k e
```

<u>Step (c)</u>: <u>Output</u>:

```
    *           line 2
   (*      .)   line 1
 (*   *)  *  *  line 0
h i p o n n a k e                     hipónnake
```

The application of (58) to an accented word is shown in (60).

(60) <u>Input</u>:   <u>Step (a)</u>:   <u>Step (b)</u>:

```
                                                  *                  line 2
     *                   *         *            (*          *)       line 1
     *     *    *       (*)   (*   *)           (*)   (*    *)       line 0
   ch u p n a k e      ch u p n a k e          ch u p n a k e
```

<u>Step (c)</u>:   <u>Output</u>:

```
     *              line 2
    (*        .)    line 1
    (*)    *    *   line 0
   ch u p n a k e                         chúpnake
```

An alternative to (58) is given in (61) with a corresponding derivation. Notice that this analysis has unbounded feet, and that it utilizes extrametricality. Although lexical extrametricality was ruled out in the above discussion of loan words, this does not necessarily preclude the assignment of extrametricality by rule as in (61).

(61) <u>Alternative analysis using extrametricality and unbounded feet</u>:

```
(a) Mark the first syllable extrametrical:
    (Cannot apply when the first syllable        <*>*   * *
     has lexical accent)                         hiponnake

                                                     *
                                                 <*>(*   * *)
(b) Construct an unbounded left-headed foot:     hi ponnake
```

It is also possible to conceive of another analysis which utilizes extrametricality, but this time with bounded feet, as in (62).

(62) <u>Alternative analysis using extrametricality and bounded feet</u>:

```
(a) Mark the first syllable extrametrical:
    (Cannot apply when the first syllable        <*>*   * *
     has lexical accent)                         hiponnake
```

(b) Construct bounded, left-headed feet from left to right:

```
       *    *
<*>(*   *)(*)
hi ponna ke
```

(c) Construct an unbounded left-headed word tree:

```
       *
   (*       *)
<*>(*   *)(*)
hi ponna ke
```

(d) Conflate lines 1 and 2.

```
       *
   (*       .)
<*>(*   *) *
hi ponna ke
```

It turns out that each of the last two analyses, i.e., (61) and (62), has to be rejected because (61) incorrectly creates unbounded feet for both accented and unaccented words, and (62) incorrectly creates disyllabic feet for both classes of word. Contrary to both of these analyses, the reduplication data from the preceding section showed not only that feet must be created prior to reduplication but also that accented words have degenerate feet, as (58) predicts. Thus, both (61) and (62) are eliminated from the list of analyses that might be proposed under the theory of H&V. This leaves (58) as the only alternative, i.e., it must be the case that right-headed feet are constructed from left to right and that the head of the leftmost foot becomes the stress of the word.

Given this conclusion, the only remaining task is to provide a formal account of Mayo's floating lexical accent within the framework of H&V's theory. Section 3.1.1.2 argued that, since the prefix *[hi-]* is stressed in accented words such as *híchupnake* but not in unaccented words such as *hipónnake,* it must be the case that lexical accent is a feature of the stem and not of the prefix *[hi-]*. Notice that this con-

clusion is independent of how a theory formalizes the properties of lexical accent. The problem for H&V's theory is, how does the lexical accent manage to move from the first syllable of a stem such as *chúpnake* over to the prefix in *híchupnake?* There is no precedence for such movement in H&V's theory, where lexical accent is assumed to be prelinked.[10] Nevertheless, within H&V's framework, there is no alternative but to stipulate that lexical accent somehow moves to the leftmost syllable following prefixation. This is illustrated in (63).

```
(63) Input:              Add Prefix:          Move Accent:

      *                     *                  *
      *    * *           *  *    * *           *  *  * *
     chupnake            hi-chupnake          hichupnake
```

If this movement of lexical accent were not stipulated, then the process of prefixation would be expected to neutralize the contrast between accented and unaccented words. As a result, all prefixed forms, including accented ones, would have second syllable stress as in (64)(b). This, however, is not the case.

(64) (a) hí-chupnake (b) *hi-chúpnake

Thus, a new kind of metrical rule is required in order to account for the Mayo data within the framework of H&V. At first glance, it might appear that this innovation could be avoided by assuming that the

[10] Although H&V allow for cyclic stress erasure, the latter cannot account for the Mayo data because lexical accent does not disappear in between cycles. Rather, it moves. The cyclic perseverance of accent is attested by the fact, noted earlier, that the contrast between accented and unaccented stems is not neutralized by affixation.

reduplication process copies the stem's lexical accent along with the rest of the melody. If this were the case, then the original accent would still be on the first syllable of the stem; conflation would presumably prevent this accent from surfacing, as illustrated in (65).

(65)

```
Input:               Add Prefix:          Copy Melody:

 *                     *                   * *
 *  *  * *             *  *  * *           * *  *  * *
hichupnake          μ- hichupnake         hihichupnake

Build Feet:          Word Tree:           Conflate:

                       *                   *
 *  *     *  *       (*  *     *  *)       (*  .      . .)
(*)(*)(*  *)(*)      (*)(*)(*  *)(*)       (*)*  *  * *
hi hichupna ke       hi hichupna ke        hihichupnake
```

This would account for the apparent movement of lexical accent following reduplication. However, this solution fails to explain how lexical accent shifts leftward onto a conventional prefix, i.e., one which does not involve reduplication, as in *[hi-] + chúpnake --> híchupnake*. It would be totally *ad hoc* to claim that every prefix copies lexical accent from the stem.

To summarize, the Mayo data require an enrichment of H&V's theory in terms of the properties that may be attributed to lexical accent. Specifically, H&V's theory must be expanded so as to allow for a cyclic rule which moves a lexical accent to the edge of a word following affixation. Without such an enrichment, H&V's theory is incapable of explaining the Mayo stress and reduplication data. In contrast, the autosegmental approach that was proposed in section 5.1.1 utilizes only

independently-required principles from prosodic theory and autosegmental theory to provide a uniform account of all the data that have been presented thus far. Thus, the Mayo data constitute an argument in favor of the autosegmental theory of stress and against H&V's theory.

5.1.4. Summary.

The preceding discussion has pointed out three significant facts about the grammar of Mayo. First, there is an underlying contrast between accented and unaccented words, and this contrast is preserved following affixation. Second, the rule of foot-building crucially has to precede and follow reduplication. Third, the reduplicative base consists of more than one syllable in unaccented words but is limited to the first syllable in accented words.

The autosegmental theory of stress accounts for all of these facts with the following analysis. First, it is assumed that accented words contain a floating stress autosegment which links from left to right at the beginning of each cycle (as well as postlexically) and delinks at some later point in the cycle. Second, the presence of a stress autosegment linked to any element that is being incorporated into a foot forces that foot to become degenerate (the Degenerate Foot Principle). Third, a stress autosegment is inserted into each (unaccented) foot and links from right to left. Except for the Degenerate Foot Principle, each of the above processes is independently attested in other languages besides Mayo. As was pointed out earlier, the Degenerate Foot Principle

is required even if some other metrical theory, such as that of H&V, is applied to the Mayo data.

H&V's theory, on the other hand, requires further enrichment in order to account for the cyclic preservation of the contrast between accented and unaccented stems. Specifically, H&V's theory must admit the possibility that lexical accent can float underlyingly. This property makes lexical accent look very much like an autosegment, raising the question of why it should be treated as formally different from an autosegment in this theory.

There is more to the story, however. These two theories differ crucially in terms of how they view the relationship between foot structure and stress. The theory of H&V assumes that heads (which eventually become the anchors for stress) are assigned at the time of foot-building, whereas the autosegmental theory of stress views foot construction and stress assignment as totally separate processes. The Mayo data presented in the next section provide further evidence in favor of the latter view and against the former view.

5.2. The Interaction of Stress and Length in Mayo.

Thus far, this chapter has examined alternations in the patterns of stress and reduplication in Mayo words containing only short vowels. These alternations were accounted for first using the autosegmental theory of stress assignment, then using H&V's theory. It was argued that the autosegmental approach is to be preferred over that of H&V because the former requires less theoretical innovation than the latter.

This section considers the remaining body of data, i.e., those words which contain long vowels and, in some cases, consonant gemination. Based upon this additional set of data, it is argued that the distribution of stress in Mayo cannot be explained using H&V's theory, nor can Hayes' theory account for it. In contrast, the autosegmental theory of stress is able to account for the patterns that are observed.

The arguments are organized as follows. Section 5.2.1 introduces two prosodic rules, Mora Insertion and Phrase-Final Extrametricality, and describes the application of these rules first to unaccented words, then to accented words. It is shown that stress can be assigned to an inserted mora in an unaccented word and that an inserted mora in an unaccented word always receives its segmental content from the preceding vowel. On the other hand, an inserted mora in an accented word usually (but not always) receives its segmental content from the following onset. These facts are explained in terms of the autosegmental analysis that was presented in the preceding section.

Next, section 5.2.2 argues that the distribution of stress in words which contain long vowels cannot be explained in terms of H&V's theory of stress, nor can Mayo feet be categorized in terms of Hayes' 1987, 1991 inventory of primitive feet. It is concluded that the autosegmental theory of stress is the only theory that is able to account for the Mayo data without appealing to any *ad hoc* devices.

5.2.1. The Minimal Word and Phrase-Final Extrametricality.

Length occurs in both vowels and consonants in Mayo, but in most cases it is derived rather than underlying. Furthermore, derived vowel length and derived consonant length are in near-complementary distribution with respect to stress. On the one hand, there is a correlation between the distribution of derived vowel length and the distribution of second syllable stress. On the other hand, there is a similar correlation between the distribution of derived consonant length and the distribution of first syllable stress. I discuss these two sets of phenomena in sections 5.2.1.1 and 5.2.1.2, respectively, and propose a straightforward formal account which makes use of the autosegmental analysis that was proposed in the preceding section. Insofar as other theories are unable to account for the same set of data (as argued in section 5.2.2), this analysis constitutes a further argument for the autosegmental theory of stress.

5.2.1.1. Derived Vowel Length and Second Syllable Stress.

Phonetically long vowels occur quite frequently in Mayo, but in many instances the length is predictable from the environment. In this subsection I propose two prosodic rules and demonstrate how they account for vowel length in most of the places where it occurs.[11]

[11]See Hagberg 1990 for a detailed discussion of Mayo vowel length, where it is argued that Mayo has two types of underlying vowel length which contrast in terms of how they syllabify. This is discussed only briefly here.

Mayo has no instances of a monomoraic word in phonetic representation, but some words can be shown to be underlyingly monomoraic. For example, the word for 'no' has the form *kaá* when it occurs as a word by itself and the form *ka* whenever anything is attached to it:

(66)	<u>Kaá</u> kó'okore. no be sick	*He is not sick.*
(67)	<u>ka</u>-tím kó'okore. no-they be sick	*They are not sick.*
(68)	<u>ká</u>-k waánte. no-location feel pain	*He doesn't feel any pain.*

(As in many other Uto-Aztecan languages, the default subject in Mayo is third person singular). The lengthening in (66) is purely phonological, as evidenced by the absence of length in (67) and (68). This alternation in vowel length occurs in the word for 'me' in the same environments: It surfaces as *neé* when it occurs as a word by itself and as *ne* when it is followed by an enclitic:

(69)	<u>neé</u> bítcha. me sees	*He sees me.*
(70)	<u>ne</u>-chím bítcha. me-they see	*They see me.*

There are two possible approaches to analyzing these length alternations: either an underlyingly short vowel gets lengthened, or else an underlyingly long vowel gets shortened. In what follows I consider first the former approach, then the latter, showing that it has to be the case that the vowel length in (66) through (70) is derived, not underlying.

If the vowel length in (66) through (70) is derived, then some kind of rule is needed which, in pre-theoretic terms, lengthens a vowel when it is the only vowel in the word. This is expressed in (71).

(71) Vowel Lengthening: $V \rightarrow V{:} \;/\; [\,(C)\_\_\_\,]_{word}$

Although Vowel Lengthening accounts for the data presented thus far, it fails to capture the following generalization about the phonetic forms of monosyllabic words in Mayo. The minimal word in Mayo contains either a long vowel or a vowel-coda sequence. That is, words of the form [CV:] are attested, as are words of the form [CVC], but [CV] is unattested in surface forms. Hyman 1985 and Hayes 1989, citing data from a number of languages, use the existence of distributional patterns such as this one as an argument for moraic theory. Thus, on the moraic tier, a long vowel is represented in exactly the same way as a sequence of vowel plus coda: in both instances there are exactly two moras.

In order to capture this generalization, Vowel Lengthening may be replaced by Mora Insertion (72), whose function is to ensure the satisfaction of a bimoraic minimal word template.

(72) Mora Insertion (MI):

$$\begin{array}{c} W \\ | \\ \mu \end{array} \quad \rightarrow \quad \begin{array}{c} W \\ / \;\; \backslash \\ \mu \quad \mu \end{array}$$

The advantage of Mora Insertion over Vowel Lengthening is that the former can treat vowel length and coda consonants in a uniform manner (assuming that codas are moraic), whereas the latter makes no predictions about consonants. Thus, while both rules are observationally ade-

quate for the data presented thus far, only Mora Insertion makes the prediction that the prosodic structure of a vowel-coda sequence is identical to that of a long vowel. In fact, this prediction has already been instantiated, for if codas were *not* moraic in Mayo, then the attested form in (68) would be **kaak* instead of *kaa*.[12] I return to this point shortly.

The length alternations in (66) through (70) involve only two words, both of which are function words. However, Mora Insertion is independently needed to account for the fact that monomoraic words are unattested in phonetic representation in Mayo. Every word, even if monosyllabic, has at least two moras in phonetic representation. Two more examples of function words are given in (73). In each of these forms, the vowel length disappears when a clitic is added, just as it does in the earlier examples involving length alternations.

(73) (a) keé *ke *not yet* (b) heé *he *yes*

Mayo also has a number of verb roots that are underlyingly monomoraic. Mora Insertion applies to these words as expected in (74) through (77). In the (a) form of each of these examples, the underlyingly monomoraic root gains a second mora from the present tense (PRES)

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[12]Further evidence for the claim that codas are moraic is presented in section 5.2.1.2, where it is shown that Mora Insertion accounts not only for derived vowel length but also for derived consonant length.

suffix. In each of the (b) forms, however, Mora Insertion applies because the root has no affixes.[13]

(74)	(a)	wé-ye *go (SG)*	(b)	wée	béchi'ibo	*in order to go*
		go-PRES		go	for	
(75)	(a)	yá-wa *make*	(b)	yáa	béchi'ibo	*in order to make*
		make-PRES		make	for	
(76)	(a)	é-ya *think*	(b)	ée	béchi'ibo	*in order to think*
		think-PRES		think	for	
(77)	(a)	ho-yé *sit (PL)*	(b)	hoó	béchi'ibo	*in order to sit*
		sit-PRES		sit	for	

I have been assuming that all of the words examined thus far contain only underlyingly short vowels; the alternative is to assume that the vowels which exhibit quantity alternations are underlyingly long. If the latter were the case, then some kind of vowel shortening rule would be needed in order to account for the forms in (67), (68) and (70) as well as the (a) forms in (74) through (77). However, there are a few Mayo words (about 5% of the stems found in Collard and Collard 1962) which contain a long vowel that never alternates with a short vowel, as illustrated in the (a) forms of (78) through (81). Each of these under-

[13]The postposition *béchi'ibo* cannot be an affix for two reasons. First, it has its own stress, and Mayo words do not exhibit multiple stresses. Second, this postposition serves as the head of an entire adverbial phrase which may contain an arbitrarily long sequence of words.

ived forms contrasts with the unrelated (b) form, which contains only short vowels.[14]

	Underived length:		No length:	
(78)	(a) yóoko	*jaguar*	(b) yóka	*paint*
(79)	(a) téeka	*sky*	(b) téku	*squirrel*
(80)	(a) naáte	*begin*	(b) nátemae	*ask*
(81)	(a) boorók	*toad*	(b) poróẃim	*type of lizard*

If it were the case that a long vowel shortens non-word-finally, as might be concluded from the data presented earlier, then there would be no explanation for the vowel length in the (a) forms of (78) through (81). If, however, each of the vowels in (66) through (70) and (73) through (77) is underlyingly short, then Mora Insertion accounts for all the length alternations, and the vowel length in the (a) forms of (78) through (81) is underlying. Thus, the correct approach to analyzing the length alternations presented thus far is to assume that underlyingly short vowels undergo lengthening as the result of a rule such as Mora Insertion. To assume the opposite, i.e., that underlyingly long vowels

[14]I know of no instance of a monosyllabic word with underlying vowel length. However, when the effects of extrametricality are considered, this argument can be made from disyllabic forms; this is discussed below. I attribute the absence of underlying vowel length in monosyllabic words to a combination of the following facts about Mayo: First, as was already mentioned, underlying vowel length is relatively rare. Second, monosyllabic words are likewise rare. Finally, as was already demonstrated, the only way to distinguish underlying length from derived length in a monosyllabic word is to add an affix (or a clitic, if the word that is being tested is a function word, but there are few monosyllabic function words) and see whether the length perseveres or not. Unfortunately, the grammar seems to have conspired so as to make it impossible to utilize this test for most words, for all but two of Mayo's affixes enter the derivation in the second lexical stratum, *after* Mora Insertion has already applied in the first stratum. These facts are discussed below and in greater detail in Hagberg 1989a.

shorten in non-final position, would fail to account for the length contrasts in (78) through (81).

To summarize thus far, Mayo has words with the surface form [CV:] as well as words with the form [CVC], but [CV] is not an attested surface form. Furthermore, a number of words exhibit vowel length only when these words would otherwise be monomoraic, whereas certain other words exhibit vowel length in all environments. In order to account for all of these facts in a uniform manner, I conclude, first, that vowel length is derived in those words which do not exhibit length in all environments and, second, that Mora Insertion rather than Vowel Lengthening is the correct way to formalize the length alternations.

Next, I examine the triggering of Mora Insertion by a phrase-level rule of extrametricality. Examples of vowel lengthening in unaccented disyllables are presented in (82) through (86). The first vowel in each of these words lengthens when the word occurs in phrase-final position but not elsewhere. I define a (phonological) phrase as any utterance that is bounded at both ends by pause.[15] Notice, also, that the (b) forms have final stress while the (a) forms do not.

	Phrase-finally:	Elsewhere:	Gloss:
(82)	(a) sií-ka	(b) si-ká	depart (SG)-PAST
(83)	(a) chaá-ye	(b) cha-yé	shout-PRES
(84)	(a) taábu	(b) tabú	rabbit
(85)	(a) kiíchul	(b) kichúl	cricket
(86)	(a) tuúrus	(b) turús	spider

[15] In many cases this corresponds to a syntactic sentence, but it is sometimes less than a sentence. In all the preceding examples as well as the examples that follow, words are presented in their non-phrase-final forms except where otherwise noted.

Neither the lengthening nor the stress shift is observed when a word has more than two syllables, regardless of its position within the phrase. This is shown in (87) through (91).

(87)	si-síka	*was departing*
(88)	chayé-ka	*shouting*
(89)	tabú-ta	*rabbit-ACCUSATIVE*
(90)	kichúl-ta	*cricket-ACCUSATIVE*
(91)	turúh-ta	*spider-ACCUSATIVE*

Since Mora Insertion has already proven useful in accounting for vowel length alternations, I follow the same approach in analyzing the alternations in (82) through (86). However, in order to account for the fact that the environment for lengthening in these examples is not actually word-final, another rule is needed to create a word-final environment. This rule, which I call Phrase-Final Extrametricality (henceforth, *PFE)*, is stated in (92), where σ represents a syllable, the angled brackets <> demarcate an extrametrical element and $]_p$ represents a phrase boundary.

(92) <u>Phrase-Final Extrametricality (PFE)</u>: $\sigma \longrightarrow <\sigma> \ / \ \_\_\_ \ ]_p$

Rule (92) renders a phrase-final syllable extrametrical and consequently unable to bear stress. Thus, each of the words in (82) through (86) has stress on the second syllable except when that syllable occurs phrase-finally, in which case stress shifts to the preceding syllable. However, as was already pointed out for the phrase-final forms, PFE triggers the application of Mora Insertion in addition to stress shift. This means that PFE has the effect of excluding the final syllable of

the phrase from the domain of the final word. This is consistent with Inkelas' 1989 claim that extrametricality is a special case of the more general phenomenon of *invisibility*.

The above discussion assumes that each of the (b) forms in (82) through (86), rather than the (a) forms, more closely represents the respective underlying form. But what if the opposite were the case? If each of the words in (82) through (86) were assumed to have (a) as its underlying form, then two problems would arise. First, the shortening of the vowel in each of the (b) forms could not be accounted for without stipulating a new rule or constraint. But the existence of underlyingly long vowels that never shorten, as exemplified in the (a) forms of (78) through (81), would make it difficult to formulate such a rule or constraint. For example, it would be incorrect to postulate a rule that shortens a long vowel preceding stress, because the long vowel in *booróotk* precedes stress (except when the word occurs phrase-finally), and yet it always surfaces as long, not short.

The second problem that emerges from assuming that the phrase-final forms in (82) through (86) are closer to the underlying representations than the (b) forms is that it entails the claim that the stress pattern of the (a) forms is derived via Mayo's regular rules of stress assignment. This, in turn, implies that, in order to derive the (b) forms, stress later shifts one syllable to the right just in case the word is not in phrase-final position. However, such rightward shifting of stress from the (a) forms to the (b) forms could not be accounted for in any principled manner. One might attempt to account for it by

proposing, as an alternative analysis of stress assignment, that stress always occurs on the second *mora* of an unaccented word instead of on the second *syllable*, as was claimed earlier. However, this is not true of either of the forms of the unaccented word in (93). The form of (93a) is identical to that of (93b), with one exception: stress occurs on the first syllable (and the first mora) in (a) and on the second syllable (and third mora) in (b).

	Phrase-finally:	Elsewhere:	Gloss:
(93)	(a) bwík-su	(b) bwik-sú	sing-COMPLETE

This argument cannot be countered by claiming that the coda in (93) is somehow non-moraic, for there is no vowel length in the uninflected form *bwik*, which can occur as a word by itself in phrase-medial position, and yet the vowel lengthening effect *is* observed when the morphology is such that no coda is created, as in (94).

	Phrase-finally:	Elsewhere:	Gloss:
(94)	(a) bwiík-a	(b) bwik-á	sing-PRES

Nor would it be correct to propose, as yet another analysis of stress assignment, that stress falls on the vowel whose syllable contains the word's second mora. This would indeed account for the phrase-final forms in (93a) and (94a), but stress in (93b) falls on the next syllable *following* the word's second mora. The same pattern may be observed by comparing (95) with (96):

		Phrase-finally:	Elsewhere:	Gloss:
(95)	(a)	noók-a	(b) nok-á	speak-PRES
(96)	(a)	nók-la	(b) nok-lá	speak-PERFECTIVE

Thus, two highly stipulatory rules would be required if the vowel length in each of the (a) forms in (82) through (86) were assumed to be underlying. First, a rule which shortens a long vowel in a certain environment would be needed in order to derive each of the (b) forms in (82) through (86), but this rule cannot apply to forms such as *yóoko* and *boorók*. Second, stress would have to somehow shift rightward in that same environment, but there appears to be no independent motivation for such movement. In contrast, these two rules are not required if it is simply assumed that the vowel length is derived in each case by Mora Insertion after the final syllable has been rendered extrametrical. Thus, stress normally falls on the second syllable in these words, and the rule of PFE (92) forces phrase-final stress to shift leftward. This sequence of events is sketched in rough form in (97).

	Input:	Phrase-Final EM:	Mora Insertion:	Stress:
(97)	s i k á	s i<k a>	s i i<k a>	s i í<k a>

To sum up what has been said thus far, Mayo has both derived and underlying vowel length. The source of derived vowel length is Mora Insertion, which is really just the means by which Mayo's minimal word template is satisfied in those cases where a word has only one underlying mora, or where one of the moras in an underlyingly bimoraic word has been rendered extrametrical by the rule of Phrase-Final Extrametricality. Thus, it has been demonstrated that the form *siíka* must be derived

from *siká* rather than vice versa, and the length alternation has been formally accounted for. However, I have not yet mentioned the mechanism by which the stress of *siíka* is derived; this is discussed next.

Assuming, as was argued earlier, that Mayo feet are disyllabic, there are two possible approaches to deriving the stress pattern of words such as *siíka*. One approach, which is argued to be the correct one, is to assume that there is no foot structure in *siíka*, and that a stress autosegment is assigned from right to left directly to the word.[16] The details of this analysis are discussed below, but first I discuss the other logically possible approach, showing why it cannot be correct.

The other possible means of deriving the stress pattern of words such as *siíka* is to assume that there *is* foot structure in these words. If this assumption is correct, however, then a question arises as to how this particular foot structure is to be formalized. In particular, is the foot binary, meaning that it is built either from two syllables or two moras, or is it a degenerate monosyllabic foot? These are the only structures that are logically possible under the model proposed here. Furthermore, since the form *siíka* occurs only phrase-finally, the final syllable *[-ka]* must be extrametrical and therefore cannot belong to the

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[16]Left to right is not an option for this rule for the following reason. If the direction of linking of the stress autosegment in *siíka* and *siká* were from left to right, then this stem would have to be lexically marked so as to keep stress from linking to the first stress-bearing unit. But it was already argued in section 3.1.1.2 that words with first syllable stress have to be lexically marked for stress, so now we would have lexical markings for both stress classes rather than for only one stress class.

foot. Consequently, the question of foot structure in this case translates into a question of syllable structure: Specifically, is the long vowel in *siíka* disyllabic, or monosyllabic? If it is disyllabic, then stress occurs on the second syllable of *siíka* just like it does in any other unaccented word. However, the following argument provides evidence that the long vowel in such words is in fact monosyllabic.

Recall from section 5.1.1 that, in words that lack vowel length, stress always occurs on either the first or second syllable; there are no instances of third syllable stress in such words. Because of this exceptionless pattern in words whose syllabification status is unambiguous, I conclude that the domain of stress in Mayo is always limited to the first two syllables of the word. This provides a useful means of determining how long vowels are syllabified in certain situations, particularly when it is the first vowel that is long.

For example, consider the data in (98). Each of these words is presented in its non-phrase-final form so as to avoid the complicating factors that are triggered by Phrase-Final Extrametricality. The (a) and (b) forms show that the underlying representation for 'sit (PL)' is *ho*, with no vowel length. In the (c) form, Mora Insertion has applied to lengthen the vowel, and stress occurs on the second mora. Although the syllabification of the (c) form is indeterminate when considered by itself, the (d) form makes it clear that the two moras of the long vowel are tautosyllabic because stress in (d) falls on the next syllable following the long vowel.

(98) (a) ho-yé sit (PL)-PRES
(b) ho-hó-te HAB-sit (PL)-CAUSE
(c) hoó sit (PL)
(d) hoo-té sit (PL)-CAUSE

If the two moras of the long vowel in *hooté* were in fact in separate syllables, then *hooté* would constitute an exception to the claim that the domain of Mayo stress is limited to the first two syllables.

A brief explanation of the above data is needed here, for the vowel length in (98c) is derived via Mora Insertion as discussed in the preceding section, but why is there vowel length in (98d) as well? In order to answer this, I assume that the rule of Mora Insertion applies only to phonological words; this makes sense given that Mora Insertion is simply a mechanism for enforcing Mayo's requirement that every word (but not a stem which has not yet become a word) must contain at least two moras at all levels of representation. If the CAUSATIVE (CAUSE) morpheme is classified as a postclitic instead of a suffix, then the minimal word constraint comes into play and triggers Mora Insertion *before* the CAUSATIVE morpheme (or any other clitic) enters the derivation.[17] In contrast, the HABITUAL (HAB) and PRESENT TENSE (PRES) affixes enter the derivation during the lexical stratum, before Mora Insertion has had a chance to apply; this explains the lack of vowel length in (a) and (b).

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[17]Based on the widely-held assumption that function words do not enter the derivation until the postlexical phase, I assume that a clitic attaches to a function word just as soon as the latter enters the derivation; the resulting form then acquires the status of a phonological word. This would explain why Mora Insertion fails to apply to function word-clitic sequences such as *ka-tím* and *ne-chím* even though it applies to their monomorphemic counterparts *kaá* 'NEGATIVE' and *neé* 'me'.

It must also be the case that the inserted mora in *hoó* receives its melody before entering the postlexical stratum. Otherwise, we would expect (98d) to have the form **hotté* (i.e., Leftward Spread would apply just as it does in certain reduplicated forms) instead of the observed *hooté*.

Thus, an underlyingly monomoraic root with no Stratum 1 (i.e., lexical stratum) affixes will undergo Mora Insertion and surface with vowel length even if it has a postlexical enclitic, as illustrated in column (a) of (99). In contrast, the same root surfaces without vowel length when it has a Stratum 1 affix, as shown in column (b).

```
(99)  Stratum 1 (Lexical):      (a)                (b)

      Underlying:                μ                  μ
                                 |                  |
                                ho                 ho

      Construct Foot:           (Insufficient syllables in both cases)

      HABITUAL:                 N/A                 μ   μ
                                                    |   |
                                                   ho-ho

      Construct Foot:           N/A                (σ  σ)
                                                    |  |
                                                    μ  μ
                                                    |  |
                                                   hoho

      Mora Insertion:            μ  μ              N/A
                                 | /
                                ho
```

<u>Stratum 2 (Postlexical)</u>:

```
CAUSATIVE:                  σ   σ             σ   σ   σ
                            |\  |             |   |   |
                            μ μ μ             μ   μ   μ
                           /|/ /|            /|  /|  /|
                           h o -t e          h o h o-t e

Construct Foot:            (σ   σ)           (σ   σ)  σ
                            |\  |             |   |   |
                            μ μ μ             μ   μ   μ
                           /|/ /|            /|  /|  /|
                           h o  t e          h o h o t e

Assign *:                       *                 *
                                |                 |
                           (σ   σ)           (σ   σ)  σ
                            |\  |             |   |   |
                            μ μ μ             μ   μ   μ
                           /|/ /|            /|  /|  /|
                           h o  t e          h o h o t e

Output:                    hooté             hohóte
```

Several points should be noted regarding the above set of derivations. First, the foot that is constructed at the end of Stratum 1 is destroyed at the beginning of Stratum 2, and * is not assigned until the very end of Stratum 2. Second, Mora Insertion has to apply after the HABITUAL morphology but before the CAUSATIVE morphology; otherwise, there would be no way to explain the length alternation between *hooté* versus *hohóte*. Finally, recall from the preceding section that foot-building has to precede as well as follow HABITUAL prefixation because this morpheme utilizes the foot as the base of reduplication. However, the stem *ho* contains only one syllable, so I assume that no foot is formed prior to

HABITUAL prefixation. Instead, I assume that the entire stem is utilized as the base of reduplication.[18]

Thus, the vowel length in *hooté* is derived via the rule of Mora Insertion, but in this case the environment is not phrase-final so the final syllable is capable of bearing stress. And since stress does in fact occur on the final syllable, it must be the case that the two moras of the long vowel are tautosyllabic. If they were not, then **hoóte* would be observed instead of *hooté*, for third syllable stress has already been shown to be disallowed in Mayo.[19]

It has thus been demonstrated that the two moras of the long vowel in *hooté* are in the same syllable, but this has significant implications for the prosodic structure of the derivationally related form *hoó* as well as for the prosodic structure of other words with derived vowel length.[20] Specifically, it must be the case that *hoó* has only one syllable. In order to see this, consider the following argument.

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[18]The alternatives would be to either epenthesize the needed material or delay HABITUAL prefixation until later in the morphology. Spring 1990 argues that the grammar of Axininca Campa utilizes both of these alternatives in that the templatic morphology is delayed until sufficient material has become available through affixation. If, at the end of the derivation, there is still not enough material to permit the required templatic morphology to apply, epenthesis is used as a last resort. The grammar of Mayo apparently does not allow either of these alternatives.

[19]In fact, *hoóte* is observed phrase-finally; this is discussed below.

[20]The clitic *-te* is quite productive and applies during the postlexical stratum, as discussed above, so it is safe to assume that *hooté* is derived from *hoó* as opposed to being a separate lexical entry; this point is crucial to the argument.

Since the first vowel in *hooté* receives its second mora *before* the cliticization of CAUSATIVE *[-te]*, one would assume that the syllabification of *hoó* takes place prior to the cliticization process and that the syllabification of the long vowel does not change following this process.

Suppose, for the sake of argument, however, that the long vowel in *hoó* were in fact disyllabic prior to CAUSATIVE cliticization, and that the disyllabic long vowel in *hoó* somehow collapsed into a single syllable (while retaining its length) following cliticization. While this set of assumptions would make it possible to have a regular disyllabic foot in *hoó* as well as in *hooté* (because both would end up with second syllable stress), I know of no independent evidence for such a resyllabification process. Furthermore, consider the following. When *hooté* occurs phrase-finally, the rule of Phrase-Final Extrametricality renders the final syllable incapable of bearing stress, as discussed above. The resulting form is *hoóte*, not **hóote*. If the stress pattern of *hoó* is to be attributed to the claim that its long vowel is disyllabic, then the long vowel in phrase-final *hoóte* must also be considered to be disyllabic since it has the same stress pattern as *hoó*. But this would imply that the long vowel in the non-phrase-final form *hooté* is disyllabic as well, for there is no reason to suppose that the application of Phrase-Final Extrametricality would trigger resyllabification. But I have already demonstrated that the long vowel in *hooté* has to be monosyllabic, so this means that the starting assumption (that the long vowel in *hoó* is disyllabic) is wrong.

The conclusion, then, is that the long vowel in *hoó* is in fact monosyllabic. But this conclusion directly implies that one of the following must be true: Either *hoó* has a binary foot built from moras, or it has a monosyllabic (i.e., degenerate) foot, or else it has no foot structure at all.

The first of these possibilities is ruled out by the observation, pointed out in section 5.1.1, that Mayo stress assignment is generally insensitive to syllable weight. The second possibility (i.e., that *hoó* has a degenerate foot) is ruled out because, since *hoó* is monosyllabic, it would imply that stress 'percolates' down to the second mora of the stressed syllable at some point in the derivation. Although such an analysis is certainly imaginable, the distribution of underlying vowel length in Mayo provides independent evidence against the claim that stress can 'percolate' down to the second mora of a syllable.

The argument is as follows. Underlying vowel length in Mayo can occur on either the first or second vowel of a word, but whenever underlying length occurs on the *second* vowel, only two stress patterns are attested: Stress can occur either on the first (short) vowel, as in (100), or else it can occur on the first mora of the second vowel, as in (101). Under the analysis that was proposed in section 5.1, it must be the case that the words in (100) are accented and those in (101) are unaccented.

(100)	<u>Accented</u>:	téwaa-tu	*name-CAUS*	pú'aate	*carry on shoulder*
(101)	<u>Unaccented</u>:	tukáa-po	*at night*	ilíikani	*narrow*
		puráato	*plate*	kulíichi	*bee*
		tiséeram	*scissors*	ujyóori	*picturesque*

Although a number of words have length on the second vowel, forms like those in (102), where stress occurs on the second mora of a non-initial long vowel, are unattested.

(102) *tukaápo *iliíkani

Since it has already been shown that *hoó* is monosyllabic, and assuming that such a syllable could occur anywhere within a word, then there ought to be instances of a disyllabic word whose second syllable has a long vowel with the stress pattern shown in (102). However, no such forms are attested. Another way of stating this is that, if it were the case that stress could 'percolate' down to the second mora of a stressed syllable, then forms like **tukaápo* would be observed any time the second vowel of an unaccented word were monosyllabic and long. Hence, the absence of forms like **tukaápo* may be explained only by assuming that stress is always realized on the first mora of a stressed syllable.

Thus, based on the distribution of stress in words with underlying vowel length, I conclude that stress is always realized on the first mora of a stressed syllable. But this means that the foot structure of *hoó,* if it has any foot structure at all, cannot possibly consist of a single bimoraic syllable, for then there would be no way to explain why stress occurs on the second mora instead of on the first one. And since it has also been argued that *hoó* cannot be disyllabic, either, there is only one possibility remaining: it has to be the case that *hoó* is devoid of foot structure. Furthermore, this conclusion applies to all

phrase-final disyllabic words with derived vowel length (such as *siíka)* since the final syllable of the latter is extrametrical.

In summary, it has been argued, both from a theoretical as well as an empirical standpoint, that the long vowel in words such as *hoó*, *hooté*, *hoóte* and *siíka* has to be monosyllabic. If it were in fact disyllabic, this would entail the claim that *hooté* has otherwise-unattested third syllable stress. But since each of these long vowels is monosyllabic, and since the theory prohibits the occurrence of degenerate feet in unaccented words, foot-building should fail to occur in short words like *hoó* and in phrase-final unaccented disyllabic forms such as *hoóte* and *siíka* (because the second syllable in each of the latter two words is extrametrical), and foot-building *should* occur in non-phrase-final *hooté*.

Empirical support for the claim that short unaccented words such as *hoó*, *hoó<te>* and *sií<ka>* lack foot structure was deduced from the following line of reasoning. The existence of non-phrase-final forms such as *hooté* and *booròk* plus the strictly two-syllable stress window in simpler forms forces one to conclude that (i) feet are syllabic rather than moraic and (ii) the long vowels in *hooté* and *booròk* are monosyllabic. In light of these conclusions, the absence of forms such as **tukaápo*, in which stress occurs on the second mora of a non-initial long vowel, forces one to conclude that stress always surfaces on the first mora of a stressed syllable. Given this set of conclusions, it must be the case that short unaccented words such as *hoó* and phrase-final disyllabic unaccented forms such as *hoó<te>*, *boó<rok>* and *sií<ka>*

do not have any foot structure at all. Rather, some non-metrical means must be used to account for the stress pattern in such words.

In fact, the autosegmental theory of stress provides a non-metrical means of assigning stress. Assuming that Mayo requires every word to surface with stress, this requirement may be satisfied in a footless word by linking a stress autosegment directly to a peripheral syllable. I claim that this is exactly what takes place. As was just argued, foot-building cannot occur in a monosyllabic word because of the foot typology (based on Hayes' 1991 theory) which I assume. If such a word does not have a lexical stress, then there is no other way for it to satisfy the above requirement except by linking a stress autosegment directly to the word. This accounts for the presence of stress in unaccented monosyllabic words and in phrase-final unaccented disyllabic words.

But there is more to the story. Notice that the Mayo data indicate that the linking of * in a footless unaccented word is in the same direction as the rule which links * within the foot, i.e., from right to left, for the stress pattern in these words is always like that of *hoó*, and never **hóo*. Consequently, the derivation of phrase-final *siíka* is claimed to proceed as follows. When the second syllable of *siká* is rendered extrametrical by the application of PFE, the existing foot structure is destroyed because it must be binary; this is illustrated in (103). No new foot can be built from syllables at this point because only one metrical syllable remains in the word. Mora Insertion applies in order to satisfy the requirement that every word have at least two

moras, and the inserted mora is immediately incorporated into the syllable, as was argued above. Then, in order to satisfy the requirement that every word surface with stress, I assume that * is inserted and links directly to the rightmost stress-bearing unit, which is the inserted mora in this case.

```
(103) Input:          Phrase-Final EM:   Mora Insertion:      Insert/Link *:

                                                                 *
                                                                 |
       (σ    σ)          σ   <σ>          σ      <σ>          σ  |   <σ>
       /|   /|          /|   /|          /|\     /|          /|\|    /|
      | μ  | μ         | μ  | μ         | μ μ   | μ         | μ μ   | μ
      | |  | ¦         | |  | |         | |     | |         | |     | |
      s i  k a         s i  k a         s i     k a         s i     k a
```

Why should it be the case that the stress autosegment in (103) links to a mora rather than to a syllable? I attribute this to the absence of foot structure. When the foot is the domain of * Insertion, the * must link first to a syllable because syllables are the terminal elements of feet in Mayo. I assume, however, that the mora is actually the stress-bearing unit, and that a foot-bound stress percolates down to the first mora of the stressed syllable. Evidence for this assumption comes from Hagberg 1988b, which is an acoustic study of Mayo stress. The relevant facts are summarized as follows.

The only acoustic feature that consistently distinguishes Mayo stress from non-stress is a relative peak in the fundamental frequency (henceforth, *pitch*). In utterances which lack vowel length (i.e., where the syllabification is unambiguous), the transition between a stressless syllable and a following stressed syllable is characterized by an abrupt

rise in pitch, whereas a string of stressless syllables exhibits a gradual drop in pitch across the entire string. Moreover, a falling pitch continues falling (or remains level) across a word boundary if the first syllable of the next word is stressless. This is illustrated in (104), which is a schematic representation of one of the utterances analyzed in Hagberg 1988b. The relative pitch of each vocalic mora is represented by a bar at the appropriate height above the vowel.

(104)

m í s i - t u k   k o s í n a - u   b í ch a   s i í - k a i

cat-DISCLAIMER   kitchen-LOCATIVE   toward   leave (SG)-IMPERF

"The cat reportedly was heading for the kitchen."

In utterances which contain one or more stressed syllables with vowel length, the same general pattern is observed, but in long vowels the pitch of one mora is always significantly different from that of the other. For example, there is an abrupt transition between the two moras of the long vowel in *siíkai*, as may be seen in the final word of (104). In contrast, the transition in pitch between the two moras of the long vowel in *yóoko* is a gradual fall which continues falling at about the same rate into the following syllable, as shown below. The pitch pattern of this word is the same regardless of whether it is uttered in isolation or phrase-medially.

(105)   y ó o k o   *jaguar*

Pierrehumbert and Beckman 1988 note a similar pattern in Tokyo Japanese and argue that (i) each abrupt rise in pitch signals the presence of a high tone and (ii) whenever the change in pitch across a sequence of several moras is gradual rather than abrupt, this indicates that these moras are not linked to a tone. This is an oversimplification, but it is adequate for the arguments to be made here. For a more technical discussion of the issues involved in interpreting acoustic data, see Poser 1984 and Pierrehumbert and Beckman 1988.

Applying the findings of Pierrehumbert and Beckman 1988 to the Mayo data, it may be concluded that *siíkai* surfaces with stress (which corresponds to a high tone in Japanese) on the second mora whereas *yóoko* surfaces with stress on the first mora. Notice that these facts are *not* consistent with the claim that stress is linked to a particular syllable node, for in that case the pitch would not be expected to vary significantly between the two moras of a long vowel.

To summarize the above argument, the acoustic pattern of the pitch of Mayo utterances indicates that Mayo's autosegmental stress ends up linking to a mora rather than to a syllable. If it were linked to a syllable, then the pitch would not be expected to vary significantly between the two moras of a long vowel. This is not the case, however. It turns out that the pitch of one mora is always significantly different from that of the other. These facts are consistent with the claim that stress is linked to moras but not to syllables in surface representation.

Given that the mora is actually the stress-bearing unit at surface representation in Mayo, it must nevertheless be the case that a foot-bound stress initially links to the syllable (presumably because the terminal elements of feet are syllables) and subsequently percolates down to the nucleus of that syllable. Otherwise, as was pointed out earlier, there would be no way to explain the absence of words such as *_tukaápo_, in which stress occurs on the second mora of a non-initial syllable.

If, however, there is no foot (as is the case for _sií<ka>;_ see figure 103), then * is inserted into the word in order to satisfy the requirement that every word surface with stress. This stress then links to the rightmost stress-bearing unit, which is the mora. Syllable structure does not matter in this case for the following reason. The rule of Mora Insertion, whose sole function is to satisfy Mayo's minimal word template in subminimal words, makes reference only to moras and not to syllables. Accordingly, I conclude that Mayo's minimal word template consists only of two moras. Since syllable structure appears to be irrelevant at this level of the derivation, and since it is precisely at this level that stress is inserted if the word has no foot structure, it follows that stress should link to a peripheral mora without regard to syllable structure in this situation.[21] In this sense, the stress auto-

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[21]If this is true, as it appears to be, then the Mayo data constitute a counter-argument to Ito's 1986, 1989 principle of Prosodic Licensing. (See also Spring 1990 and Crowhurst 1991b). This principle asserts (among other things) that the presence of a prosodic word always implies the presence of corresponding foot structure in a language whose grammar makes reference to feet.

segment is behaving in a manner which directly parallels the behavior of autosegmental tones in languages that lack foot structure altogether.[22]

Notice that the above account constitutes an argument against Hayes' 1991 claim that there is no grammar which utilizes a right-headed (i.e., right-stressed) quantity-insensitive foot. Hayes acknowledges that such feet surface in some languages, but he argues that all such languages lack a syllable weight distinction at the point in the derivation where stress assignment applies. Consequently, according to Hayes, these superficially symmetric feet are actually asymmetric feet. That is, the grammar calls for asymmetric feet but, since no weight distinction exists, the asymmetric feet that get built are indistinguishable from right-stressed disyllabic feet.

However, Mayo constitutes a clear counter-example to Hayes' claim. As the preceding discussion demonstrated, Mayo has an underlying weight distinction as well as a rule of mora insertion which applies prior to at least some of the cyclic applications of foot-building. Nevertheless, foot-building is insensitive to syllable weight, as evidenced by forms with an initial stressless underlyingly long vowel such as *boorók*. Thus, the Mayo data instantiate a grammar which creates right-stressed disyllabic feet even though a weight distinction exists at the point at which feet are built.

Thus, the stress pattern of *siíka* (figure 103) is accounted for. However, one more step is needed in the derivation in order to explain

---

[22]For arguments for the claim that tone is universally mapped to moras and not to syllables, see Peng 1992.

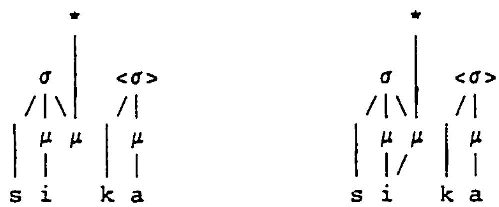
how the inserted mora receives its segmental melody. It was argued in the preceding section that the unassociated mora which sometimes occurs as a by-product of reduplication receives its melody via Leftward Spread, i.e., from the segment to its right.[23] However, *siíka* evidently receives its melody from the segment to the *left* of the inserted mora; how is this difference to be explained?

I assume that an inserted mora does not receive its melody until sometime *after* the stress autosegment has been assigned to it, as implied in the output of (103). (Recall, however, that a mora which is inserted during the lexical phase receives its melody prior to entering the postlexical phase; otherwise we would expect **hot-té* instead of the observed *hoo-té* in non-phrase-final position). The fact that the inserted mora has a * linked to it may then be used to account for the failure of Leftward Spread to apply: Since the feature set corresponding to *[k]* is never the sole bearer of stress in Mayo (and probably not in any other language, either), it is not possible for the root node of *[k]* to associate to the inserted mora.[24] The only other option, then, is for the vowel to spread its melody rightward, as illustrated in (106).

[23]Furthermore, the next section provides independent evidence that Mayo's grammar specifies the direction as Spread as leftward.

[24]I leave open the question as to whether the prohibition against stress-bearing consonants is universal or language-particular.

(106) <u>Output of (103)</u>: <u>Rightward Spread</u>: <u>Final Output</u>:



siíka

The separation of constituency from stress is crucial to the above analysis. In order to see this, consider the following argument for the claim that feet are not assigned stress until after the application of Phrase-Final Extrametricality, i.e., at a very late point in the derivation.

If it were assumed that the foot in the input to (103) had a stress autosegment as shown in (107a), then one would expect this stress to delink following the application of Phrase-Final Extrametricality, as shown in (107b). This, however, presents a problem: Where does the stress go after it delinks? Autosegmental theory does not allow it simply to 'disappear'. Rather, it has to either relink somewhere else or remain floating. If it were to remain floating and finally 'disappear' at the end of the derivation via Stray Erasure (Ito 1986, 1989), then Leftward Spread would be free to apply and there would be no way to explain why the output is *siíka* instead of **síkka* or even a stressless **sikka*.

If, on the other hand, the delinked * were to relink, the resulting stress pattern would be determined by the relative order of Mora Insertion and relinking. If * were to relink prior to Mora Insertion, there would be only one stress-bearing unit available at that time, so *

would end up on the first mora of the word as shown in (107c).[25] Leftward Spread would then be free to apply, as shown in (107e). However, this is not observed.

(107) (a) <u>Input</u>:

```
     *
     |
 (σ  σ)
  |  |
  μ  μ
 /| /|
 s i k a
```

(b) <u>PFE</u>:

```
     *
     ‡
  σ <σ>
  |  |
  μ  μ
 /| /|
 s i k a
```

(c) <u>Relink</u>:

```
  *
  |
  σ <σ>
  |  |
  μ  μ
 /| /|
 s i k a
```

(d) <u>Mora Insertion</u>:

```
  *
  |
  σ    <σ>
  |\    |
  μ μ   μ
 /|    /|
 s i   k a
```

(e) <u>Spread</u>:

```
  *
  |
  σ    <σ>
  |\    |
  μ μ   μ
 /|  \ /|
 s i   k a
```

(f) <u>Output</u>:

**síkka*

Suppose, however, that * were to relink *after* the application of Mora Insertion. In that case, * might be expected to shift to the nearest available mora. The presence of * on this mora would then be expected to block Leftward Spread from applying, as was argued earlier, yielding the correct output *síka*. This analysis is illustrated in (108).

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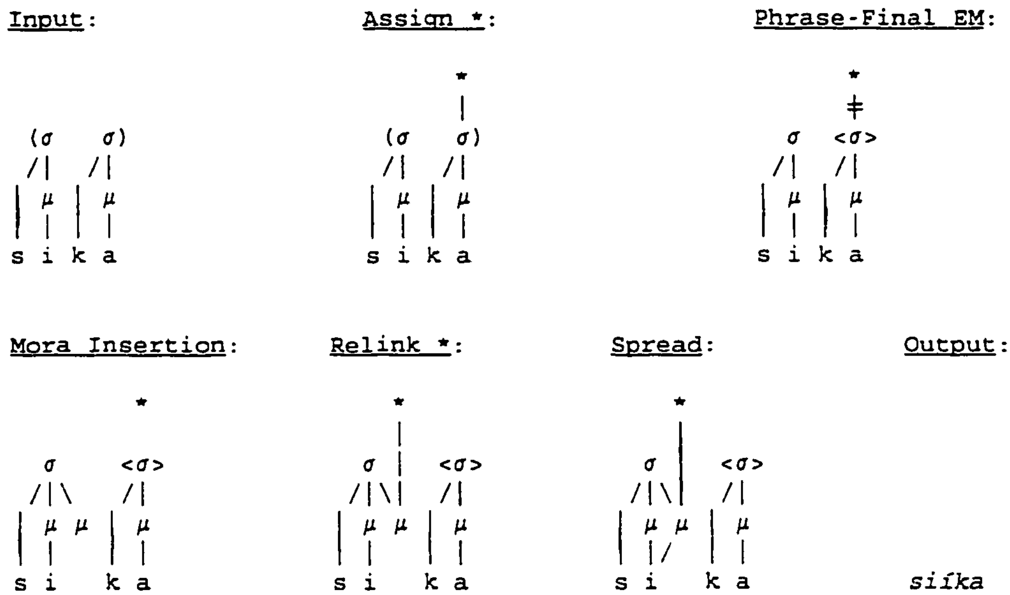
[25]Such relinking might also be expected to trigger degenerate foot construction, which I do not represent in (107).

(108)



The above derivation is plausible when considered in isolation, but in fact it cannot be utilized to account for the stress pattern of monosyllabic unaccented words such as *hoó* and *kaá*. Extrametricality plays no role in the derivation of these words, and yet their stress pattern contrasts with that of monosyllabic accented words such as *wée* 'go (SG)' and *yáa* 'do' (see figures (74) and (75)). On the other hand, the right to left linking of * to the unaccented forms (and the left-to-right linking of lexical * in accented forms, as argued in section 5.1.2) correctly derives this contrast. I conclude, therefore, that the right to left assignment of * to a footless unaccented word is needed independently of the way in which * interacts with extrametricality. This is not possible in a theory which treats stress and metrical feet as inseparable.

In conclusion, this section has demonstrated two significant facts about unaccented Mayo words. It was observed, first, that stress can be

linked directly to an inserted mora in order to satisfy Mayo's requirement that every word have exactly one *. Second, it was shown that an inserted mora always receives its segmental content from the preceding vowel in unaccented words. These observations were explained in terms of the autosegmental analysis that was presented in section 5.1, and it was argued that foot-building does not occur in monosyllabic unaccented words even though they surface with stress. This conclusion was supported not only by theory-internal arguments but also by independent arguments that were based upon the distribution of stress in words that contain long vowels.

Next, I demonstrate that the rules of Mora Insertion and Phrase-Final Extrametricality apply to accented words in exactly the same manner as they apply to unaccented words, and yet the surface forms differ significantly from those of unaccented words not only in terms of stress but also in terms of the application of the rule of Leftward Spread. These differences are readily explained by the principles of autosegmental theory.

5.2.1.2. Derived Onset Gemination in Accented Words.

As was mentioned earlier, approximately half of the words in Mayo exhibit the presence of lexical accent. These words differ from unaccented words not only in stress placement but also in the type of quantity alternation that occurs following the application of Phrase-Final Extrametricality and Mora Insertion. This is illustrated in (109) through (113). Notice that phrase-final lengthening occurs not on the

penultimate vowel, as was observed for unaccented words in the preceding section, but on the following consonant.

	Phrase-finally:	Elsewhere:	Gloss:
(109)	míssi	mísi	cat
(110)	chókki	chóki	star
(111)	kóbba	kóba	head
(112)	tóppa	tópa	stomach
(113)	tónno	tóno	knee

This phrase-final onset gemination is not attested when the first syllable is already bimoraic. This can be seen by comparing (114) with (115) and (116) with (117).

	Phrase-finally:	Elsewhere:	Gloss:
(114)	(a) chúpp-a	(b) chúp-a	harvest-PRES
(115)	(a) chúp-su	(b) chúp-su	harvest-COMPLETE
(116)	(a) mákk-a	(b) mák-a	give-PRES
(117)	(a) mák-la	(b) mák-la	give-PERFECTIVE

Thus, accented words exhibit quantity alternations in an environment that corresponds, in all relevant respects, to the environment that was attested for similar alternations in unaccented words in the previous subsection. However, the respective quantity alternations in these two classes of words differ in one crucial aspect: accented words exhibit onset gemination while unaccented words exhibit vowel lengthening. Under the autosegmental approach, this difference is accounted for as follows.

It was already argued that Leftward Spread cannot apply in an unaccented word because to do so would result in a consonant bearing

stress. Consequently, the inserted mora receives its melody from the vowel to its left. In contrast, the corresponding inserted mora of an accented word cannot be assigned a * because the word already has a linked lexical * at this point; the OCP would block the linking of another * adjacent to the existing one. Now, given that an inserted mora in an accented word cannot be assigned a *, the inserted mora is free to participate in Leftward Spread. In other words, the condition which blocks Leftward Spread in unaccented words cannot occur in accented words.

The derivation for unaccented words was illustrated in the preceding section. Next, a sample derivation for accented words is given in (118).[26] The input (step a) corresponds to the output of the lexical stratum. In step b, the floating accent links and foot-building subsequently constructs a degenerate foot; these two processes are collapsed into a single step for convenience. Next, Phrase-Final Extrametricality applies. Unlike what occurred in the derivation of the disyllabic unaccented word, the application of this rule has no effect on the existing foot structure because the foot is degenerate. However, Mora Insertion still applies (step d). In this case, the inserted mora is free to participate in Leftward Spread because it is not associated to a stress autosegment, as was the case for the unaccented word. As a result, consonant gemination occurs (step e) instead of the vowel lengthening that is observed in unaccented words.

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[26]Syllable nodes have been omitted from (118) for ease of representation. I assume in steps (d) and (e) that the two moras in the foot are tautosyllabic.

```
(118) (a) Input:          (b) Link, Degen Σ:      (c) Phrase-Final EM:

            *                   *                      *
                                |                      |
            μ   μ              (μ)  μ                 (μ)  <μ>
           /|  /|              /|  /|                 /|   /|
          m i s i             m i s i                m i  s i

      (d) Mora Insertion:   (e) Spread:            (f) Output:

            *                   *
            |                   |
           (μ μ)  <μ>          (μ μ)  <μ>
           /|      /|          /|   \ /|
          m i     s i         m i    s i                míssi
```

Recall that the rule of Leftward Spread was independently motivated in section 5.1.2 on the basis of the facts of reduplication. The following data provide further evidence that the grammar specifies the direction of Spread as leftward, not rightward. Stress occurs on the first syllable of *báre* 'intend' and *táruk* 'roadrunner' in all environments, as shown in (119) and (120); this indicates that both words have lexical accent. Nevertheless, both exhibit phrase-final vowel lengthening instead of the expected onset gemination. Notice, however, that the phrase-final form of each of these words differs from that of unaccented words in that stress generally occurs on the second mora of a phrase-final unaccented word, whereas it occurs on the first mora of these (and all other) accented words.

	Phrase-Finally:		Elsewhere:	Gloss:
(119)	báare	*bárre	báre	intend
(120)	táaruk	*tárruk	táruk	roadrunner

This unexpected vowel lengthening may be reconciled with the normal pattern of onset gemination if it is assumed that Mayo has a language-specific constraint which prohibits *[r]* from being moraic. This assumption is supported by the observation that *[r]* is never found in coda position in Mayo words, nor does it ever geminate. Given this constraint, the vowel length alternations in (119) and (120) may be attributed to the blocking of the rule of Leftward Spread that was illustrated in (118). In these words, therefore, the inserted mora has to receive its melody via rightward spread, as was argued (for a slightly different reason) for unaccented words.

This explanation is available only if it is assumed that the direction of the spread rule as specified by the grammar is leftward, for this is the direction that is attested for the reduplication data of section 5.1.2 as well as for the data in (109) through (113), and the exceptions have been explained in terms of independently-needed constraints. In contrast, if the direction of the spread rule were specified to be rightward, then it would not be possible to utilize existing rules and constraints to account for those cases in which the direction of spread is actually leftward.

In summary, the autosegmental approach is able to formally relate the contrast between vowel lengthening and consonant gemination to the absence versus presence of lexical accent, respectively, by assuming that the direction for the rule of spread is leftward, and that this rule applies late in the derivation both lexically and postlexically. In particular, when it applies during the postlexical phase it has to be

ordered after the insertion and linking of * in monosyllabic unaccented words.

In section 3.1.1.2, the possibility was raised that Mayo's contrast between first and second syllable stress might be represented by including a 'pure diacritic' in the underlying representations of words in one of the two stress classes. This diacritic would have the effect of preventing a word from undergoing the regular rules of stress assignment, forcing it to undergo some other set of rules instead. The problem with such an approach is now apparent in that the observed correlation between stress class and lengthening class would be totally coincidental. In other words, the analysis would have to stipulate something like the following: 'Words of class A have first syllable stress and exhibit consonant gemination; words of class B have second syllable stress and exhibit vowel lengthening.' In contrast, the autosegmental analysis proposed here relates a word's stress pattern to its lengthening pattern in a principled way. For this reason, the autosegmental analysis is to be preferred over a 'pure diacritic' analysis.

The next section considers how the theories of H&V and Hayes might handle the above Mayo data. It is argued that neither of these theories is able to account for all of the facts of Mayo stress in a uniform manner. This constitutes yet another argument against the theories of H&V and Hayes and in favor of the autosegmental theory of stress.

5.2.2. Further Problems for Other Theories.

It was pointed out in the preceding section that Mayo has both derived and underlying vowel length, and an autosegmental account of both derived vowel length and derived consonant gemination was presented. This section evaluates two theories of stress, that of H&V and that of Hayes 1987, 1991, in terms of their ability to account for the same data that were presented in the preceding sections. I conclude that neither of these theories is able to predict the alternations that occur, especially in words with long vowels.

I consider first the theory of H&V, and then Hayes' theory.

5.2.2.1. Analyzing the Mayo Data Using the Theory of Halle and Vergnaud.

An important assumption of H&V's theory is the Faithfulness Condition, which claims that there is always a one-to-one correspondence between prominence and constituency in the output of the phonology. In what follows I show that the interaction of stress with segmental lengthening effects in Mayo provides an indirect argument against the Faithfulness Condition.[27]

The preceding section demonstrated, using the autosegmental analysis that was proposed for Mayo, that the stress pattern of phrase-final disyllabic unaccented words such as *sífka* cannot be accounted for unless it is assumed that foot-building occurs much earlier in the derivation

[27]This argument against H&V's Faithfulness Condition also constitutes an argument against Hayes' 1991 Bijectivity Principle, for these are essentially equivalent to one another.

than the rule which inserts a stress autosegment into feet; this supports the claim that feet are inherently headless.[28] Consider, now, how the analysis that was arrived at using H&V's theory might attempt to formally relate the contrast between vowel lengthening (as in *siíka)* and consonant gemination (as in *míssi)* to the independently-needed contrast between unaccented and accented words. As was argued earlier, there has to be some way to formally relate these two sets of phenomena, for the presence or absence of lexical accent is the only thing that consistently determines whether it will be the vowel or the consonant that lengthens in these words.

It turns out that there is no way to accomplish this using H&V's theory apart from stipulation. For example, the analysis that was devised in section 5.1.3 on the basis of H&V's theory assumed that a single foot-building algorithm, repeated in (121), applies to every Mayo word so as to produce binary feet in unaccented words and degenerate feet in accented words.

(121) Mayo Stress Assignment (Using H&V's theory):

(a) Construct bounded right-headed feet from left to right.
(b) Construct an unbounded left-headed word tree.
(c) Conflate lines 1 and 2.

---

[28]Halle and Vergnaud 1987b (page 172) claim, for theory-internal reasons which I do not discuss here, that lexical accent cannot be utilized by a grammar that creates headless feet. Thus, the existence of headless feet in Mayo (as instantiated in the foregoing discussion) constitutes another counter-argument to H&V's theory.

Using this analysis, the derivation of stress and length following the application of Phrase-Final Extrametricality is illustrated in (122) and (123) for an unaccented word and an accented word, respectively.

```
(122) Input:          Phrase-Final EM:     Mora Insertion:     Refoot:

          *                                                        *
         (*)                                                      (*)
      (*    *)           *  <*>              * *  <*>           (* *) <*>
     s i k a          s i k a             s i µ k a          s i µ k a

     Spread:              Output:

        *
       (*)
      (* *) <*>
     s i i k a            siíka
```

Notice that the inserted mora in (122) is assigned its own line 0 asterisk; this is because H&V's formalism requires that a segment have a line 0 asterisk in order to be eligible to bear stress. The empty mora is then forced to copy the melody of the vowel rather than the consonant, since the latter is incapable of bearing stress. In order to be consistent, however, the inserted mora in (123) is likewise assigned a line 0 asterisk. This time, the inserted mora ends up in a foot by itself because the lexical accent forces the initial foot to be degenerate. But now the empty mora is formally stressable even though it never actually surfaces with stress, so it should be unable to copy the melody of the consonant, and **míisi* should be the output.

```
(123) Input:          Phrase-Final EM:    Mora Insertion:     Refoot:

        *                                                        *
       (*    .)         *                  *                    (*   .)
       (*)   *          *   <*>            *   *   <*>          (*)  *   <*>
      m i  s i        m i  s i           m i   μ  s i          m i  μ  s i

      Spread:              Output:

        *
       (*    .)
       (*)  *   <*>
      m i   i s i           *míisi
```

In fact, *míssi* is the attested output, so something is wrong with the above analysis.

The problem cannot be attributed to rule ordering, for the inserted mora in *siíka* has to be assigned a line 0 asterisk before either the Refooting rule or the Spread rule applies, and it is the line 0 asterisk that is claimed to prevent Spread from copying the consonant. Furthermore, if one were to assume that an inserted mora does *not* have its own line 0 asterisk, then although the correct accented form *míssi* could now be derived, there would no longer be any way to explain how the inserted mora in *siíka* acquires its line 0 asterisk.

It turns out, then, that Mayo's relationship between quantity alternations and stress class has to be derived under H&V's theory via a stipulative rule such as *spread leftward if the word is accented, else rightward*; another possible analysis would be *spread rightward to a stressed empty mora, else leftward.* While such rules would generate the correct outputs, they open up the possibility of other rules such as *spread leftward if the word contains [+NASAL], else rightward*, or *spread rightward to a nasalized empty mora, else leftward.* Since such rules

seem to be unattested, and since there is almost no limit to the number of logically possible but unattested rules that this approach would admit, I conclude that H&V's theory is incapable of accounting for the Mayo data in a principled manner.

In fact, any analysis which assumes a one-to-one surface correspondence between prominence and constituency (i.e., the Faithfulness Condition and Hayes' 1991 Bijectivity Principle) will have to stipulate the relationship between stress class and lengthening class in terms of an *ad hoc* rule, for there is no principled means available for relating the size or type of a foot to the direction of a spread rule.[29] In contrast, the autosegmental theory of stress is able to formalize the relationship between stress class and lengthening class by treating stress as an autosegment which can exist independently of feet; no *ad hoc* devices are necessary.

Next, I apply Hayes' theory to the Mayo data and show that it, too, is unable to provide a uniform account of the patterns that are observed.

---

[29]Another explanation for Mayo's contrast between vowel lengthening and consonant gemination is suggested in Burnham 1988, where the contrast between the two types of lengthening is attributed to a lexical contrast between two types of vowels. Specifically, Burnham claims that the [i] in words like *siká* has the ability to lengthen itself in the appropriate phrasal context, resulting in *siíka*, while the [i] in words like *mísi* has the ability to lengthen the following consonant in that same phrasal context, resulting in *míssi*. This approach, however, fails to relate the lengthening contrast to the stress contrast. That is, the fact that the first type of vowel occurs only in unaccented words while the second type occurs only in accented words is a distributional accident.

5.2.2.2. Categorizing Mayo Stress using the Theory of Hayes.

As was discussed in section 1.2.2, Hayes 1987, 1991 argues for the inventory of primitive foot types that is shown in (124). In the representations of the moraic trochee and the iamb, the *or* construction means that the leftmost representation is constructed wherever possible. Otherwise, the rightmost representation is constructed. In the case of the iamb, there is a three-way hierarchy of preferences; the leftmost representation is the preferred iambic foot.

(124) Hayes' 1987, 1991 Foot Inventory:

KEY: σ_{μ} = light syllable; $\sigma_{\mu\mu}$ = heavy syllable; σ = any syllable

Syllabic Trochee:	(* .) $\sigma\ \sigma$			
Moraic Trochee:	(* .) $\sigma_{\mu}\sigma_{\mu}$ or	(*) $\sigma_{\mu\mu}$		
Iamb:	Preferred:		Else:	
	(. *) $\sigma_{\mu}\sigma_{\mu\mu}$		(. *) $\sigma_{\mu}\sigma$ or	(*) $\sigma_{\mu\mu}$

Now consider how Mayo might be categorized within this system. Recall that codas are moraic in Mayo, as evidenced by the failure of Mora Insertion to apply to words like (125a) *bwíksu (*bwiíksu)* following the application of Phrase-Final Extrametricality. Nevertheless, neither

long vowels nor codas seem to affect stress assignment.[30] This is evident from the non-phrase-final form of *bwiksú (*bwíksu)* and *hooté (*hoóte)* in (125b) and (126b), respectively, for if stress assignment were sensitive to syllable weight, then one would expect to find *bwíksu* and *hoóte* (or **hóote)* in all environments, not just phrase-finally.

		Phrase-finally:		Elsewhere:	Gloss:
(125)	(a)	bwík-su	(b)	bwik-sú	sing-COMPLETE
(126)	(a)	hoó-te	(b)	hooté	sit (PL)-CAUSE

In terms of Hayes' foot inventory, then, it would appear that Mayo feet are not iambic. If they were, then the heavy syllable in a word like *bwiksú* would be expected to attract stress, but this is not observed.

This leaves only the two types of trochees as possible foot types for Mayo. It might seem that accented words such as *mísi* and *híchupa* could be categorized as syllabic trochees. However, Hayes claims that trochees are optimally binary, and yet the facts of Mayo reduplication clearly indicate that accented words do not have binary feet.[31] Consequently, those Mayo words which exhibit first syllable stress cannot be classified as syllabic trochees. Furthermore, they cannot be moraic trochees for two reasons. First, the moraic trochee is optimally bi-

---

[30]As the preceding section demonstrated, vowel length sometimes does perturb stress assignment, but the alternations that occur cannot be accounted for simply by saying that stress is attracted to heavy syllables. On the contrary, the interaction that is observed between stress and vowel length only serves to further complicate the picture if it has to be explained in terms of Hayes' theory.

[31]See section 5.1.2 for the arguments for this conclusion.

nary, and it has already been argued that words with first syllable stress have degenerate feet. Second, the moraic trochee is sensitive to syllable weight, and it was already demonstrated in section 3.2.1.2 that neither of Mayo's two stress types is sensitive to syllable weight. I conclude, therefore, that the stress pattern of words with first syllable stress cannot be attributed to moraic trochees.

It might seem possible to categorize the feet in words with second syllable stress as syllabic trochees by claiming that the first syllable of every such word is extrametrical, either by rule (in which case lexical accent blocks extrametricality from applying to words with first syllable stress) or because it is lexically marked as such. However, this proposal will not work for the following reason. The preceding section showed that, whenever the rule of Phrase-Final Extrametricality applies to a disyllabic word with regular second syllable stress, its stress shifts to the first syllable. If the first syllable were already extrametrical, then it would not be possible for Phrase-Final Extrametricality to apply because, as is argued in Hayes 1982a and Inkelas 1989, a rule of extrametricality cannot apply if it would render an entire word extrametrical. I conclude, therefore, that the extrametricality analysis cannot be correct.

In conclusion, it is simply not possible to categorize either of Mayo's two stress patterns in terms of Hayes' inventory of primitive feet. In fact, if one were to attempt to categorize the stress pattern of each individual Mayo word as an instance of one of Hayes' primitive foot types, it would be necessary to utilize all three types, and some

stems would have to be categorized as more than one type because of the stress alternations which result from the application of Phrase-Final Extrametricality. Thus, the descriptive generalization about Mayo stress, i.e., that every stem exhibits one of two simple stress patterns in all of its forms, would be lost. This appears to be unavoidable if Hayes' theory of stress is assumed.

5.2.3. Summary.

The foregoing discussion has shown that the autosegmental approach is able to account not only for Mayo's cyclic perseverance of stress under affixation but also for the complex quantity alternations which are observed. In particular, the contrast between vowel lengthening and consonant gemination in phrase-final disyllabic words has been tied to the absence versus presence of lexical accent, respectively. This analysis entails the twin assumptions that (i) the grammar specifies the direction for the rule of Spread as leftward, and (ii) this rule is ordered after the insertion and linking of * in monosyllabic unaccented words.

In contrast, it was argued that the theories of H&V and Hayes 1991 are unable to account for all of the facts of Mayo stress and quantity in a principled manner. Furthermore, both H&V's Faithfulness Condition and the Bijectivity Principle, which is Hayes' counterpart to the Faithfulness Condition, fail to find support in the Mayo data. On the contrary, the facts of Mayo stress clearly indicate not only that headless feet are created, but also that there are footless words which sometimes

surface with stress. Thus, stress and feet have to be completely separate in the rules of Mayo stress assignment. These observations argue in favor of the autosegmental nature of stress as well as the inherent headlessness of feet, and against the theories of H&V and Hayes 1991.

The next section is concerned with the facts of stress assignment in Tagalog. It is argued that Tagalog has lexical accent in affixes as well as in stems, and the autosegmental theory of stress is utilized to account for the Tagalog stress patterns in essentially the same way as it was used to account for the stress patterns of Mayo. In contrast to Mayo, which requires a metrical analysis because of the facts of reduplication, it is argued that a non-metrical analysis of Tagalog stress is equally plausible.

5.3. Floating Accent in Tagalog.

This section examines another case of floating accent, this time from Tagalog, which exhibits a contrast between penultimate and final stress. Applying the autosegmental theory of stress, two analyses are proposed. The first analysis builds a syllabic foot from right to left and later inserts and links a stress autosegment from left to right. In this view, Tagalog stress assignment is essentially the mirror image of Mayo stress assignment. The other analysis does not make use of foot-building. Rather, a rule of extrametricality applies to an unaccented word-final syllable and a stress autosegment is subsequently inserted and linked to the rightmost metrical stress-bearing unit. Each of these analyses utilizes only principles that are independently required in or-

der to account for non-metrical phenomena in a variety of languages, but each analysis depends crucially upon the assumption that stress is an autosegment. In contrast, it is argued that the theories of H&V and Hayes 1991 are incapable of accounting for the stress patterns of Tagalog without resorting to *ad hoc* devices.

The facts of Tagalog stress, as described in Ramos 1971, Schachter and Otanes 1972, Soberano 1980, French 1988 and Myers 1989, may be summarized as follows: Stress always falls on either the penultimate or final syllable, and for a given stem there is no way to predict from the phonology which of these two patterns will be observed. According to French 1988 (page 63), stress is realized phonetically as a relative peak of pitch and, on non-final syllables, phonetic vowel lengthening co-occurs with stress. This claim is supported by Soberano 1980, who states that stress is phonetically 'characterized by relative pitch and length prominence in nonfinal syllable position, or by relative pitch prominence in syllable-final position' (page 34).[32] Examples are given in (127). I utilize French's orthography except for the addition of length (indicated by a colon) which is included here for clarity.

[32]Actually, Soberano claims that all vowel length is underlying and that stress is assigned to long vowels. As French 1988 points out, however, this analysis fails to account for the limited distribution of long vowels, whereas a metrical analysis is able to account for it.

(127) <u>Tagalog Stress</u> (French 1988):

Penultimate stress:		Final stress:	
pú:no?	*trunk of a tree*	punó?	*full*
bá:soh	*drinking glass*	basóh	*target practice*
bú:kas	*tomorrow*	bukás	*open*
tá:sah	*cup*	tasáh	*having the point sharpened*
ará:lan	*place for studying*	aralán	*apprentice*
ka?ibí:gan	*friend*	ka?ibigán	*desire, inclination, preference*

This contrast in stress placement is preserved under most affixation, as illustrated in (128). Notice that stems with penultimate stress surface with penultimate stress following suffixation, and stems with final stress surface with final stress following suffixation.

(128) <u>More Tagalog Stress</u> (French 1988):

?á:ral	*study*	ará:l -an	*place for studying*
bá:sa	*read*	basá:-hin	*to read*
pá:sok	*enter*	pasú:k-an	*(so) places (something) inside of X*
dugó?	*blood*	dugu -án	*bloody*
?upó?	*sit*	?upo?-án	*(so) sits on X*
bilíh	*to buy*	bilh -ín	*to buy X*

The above facts are readily accounted for by the autosegmental approach to stress. Specifically, I claim that Tagalog has floating accent just like Mayo, but in Tagalog the accent links from right to left, as shown in (129), instead of from left to right as in Mayo.

```
(129)     *                           *
                                      |
        σ   σ         —>        σ     σ
       /|  /|                  /|    /|
      d u g o ?              d u g o ?
```

Unlike Mayo, I know of no empirical argument for cyclic linking and delinking in Tagalog. In fact, it turns out that the processes of linking (of lexical accent), foot-building and insertion/linking of a stress autosegment in an (unaccented) foot are only postlexical. For the moment I assume these claims; the arguments are presented below.

Assuming that penultimate stress is unmarked in Tagalog, a single syllabic foot is constructed on the right edge of an unaccented word and a stress autosegment is later inserted and linked to that foot from left to right, as illustrated in (130).[33] (Since vowel length is predictable, I omit it from this and subsequent derivations).

```
(130) Input:          Build Foot:        Insert & Link *:     Output:

                                              *
                                              |
        σ   σ         (σ   σ)             (σ   σ)
       /|  /|         /|  /|              /|  /|
      b a s a        b a s a             b a s a             bá̄sa
```

In the case of an accented word, I assume that linking of the accent precedes foot-building, but nothing in my analysis hinges on this. If

---

[33]Unlike Mayo, there is little independent evidence from Tagalog's prosodic morphology to support the claim that foot-building occurs on the right edge of the word, for most of Tagalog's reduplicative morphemes (as well as its so-called *infixes*, as McCarthy and Prince 1990 point out) are prefixes. The one exception that I have found is a reduplicative process that copies the final syllable of a proclitic string, as in *nakà-ka=kilití?* 'ticklish' (French 1988). Although this process copies only a single syllable, it appears that a disyllabic base is required in order for reduplication to occur. This is evidenced by the fact that, although there are monosyllabic proclitics, as in kà=sundú?-an 'agreement', French includes no examples of reduplication in which the base is monosyllabic. If it is true that reduplication cannot apply to monosyllabic bases, this constitutes a morphological argument for the existence of right-to-left foot-building.

this assumption is correct, then the presence of * on the final syllable forces the foot-building process to form a degenerate foot, just as it does in the initial syllable of Mayo's accented words. This results in final stress, as illustrated in (131).

```
(131) Input:               Link Floating *:        Build Foot:

         *                       *                       *
                                 |                       |
       σ   σ                   σ   σ                   σ  (σ)
      /|  /|\                 /|  /|\                 /|  /|\
     d u g o ?               d u g o ?               d u g o ?

      Insert & Link *:     Output:

      Blocked by OCP       dugó?
```

If, on the other hand, foot-building precedes the linking of the accent, then accented words will end up with right-stressed feet as in (132). The OCP will still prevent the application of the regular rule which inserts and links a stress autosegment from left to right in the foot.

```
(132) Input:               Build Foot:             Link Floating *:

         *                       *                       *
                                                         |
       σ   σ                  (σ   σ)                 (σ   σ)
      /|  /|\                 /|  /|\                 /|  /|\
     d u g o ?               d u g o ?               d u g o ?

      Insert & Link *:     Output:

      Blocked by OCP       dugó?
```

Notice that the above analysis is straightforward, making use of only the basic principles and parameters that were proposed in chapter

2. In contrast, all previous attempts to account for the facts of Tagalog stress have relied upon mere description and/or the use of *ad hoc* devices. For example, the heart of French's 1988 analysis is repeated below:

(133) <u>Tagalog Stress Assignment for Verbs</u> (French 1988:66):

> Word-level stress (ultima or penultima) of the verb stem is copied onto the corresponding syllable (ultima or penultima) after the last resyllabification.

The idea behind French's rule (133) is that a verb copies the stress of a stem onto its affixed counterpart in such a way as to satisfy the requirement that stress in each of that stem's derivatives must be either penultimate or final (depending on the lexical stress class of the stem). While such a rule derives the correct results, it is really nothing more than a description of the facts; it fails to formalize these facts in terms of independently needed phonological devices.

However, there are yet more facts to be accounted for. As both Ramos 1971 and Myers 1989 point out, Tagalog has two suffixes which alter the stress pattern of the stem. The first of these is, by my analysis, a floating stress autosegment which is devoid of all other content. Since its semantic function is to transform nouns into adjectives, I refer to it as the *ADJECTIVIZER suffix*. As illustrated in (134), it causes stems with normally penultimate stress to acquire final stress.

(134)	bí:his	*way of dressing*	bihís	*dressed up*
	gú:tom	*hunger*	gutóm	*hungry*
	bú:tas	*hole*	butás	*punctured*
	bí:lang	*number*	biláng	*counted*
	bá:li?	*fracture*	balí?	*fractured*

The derivation of stress in an unaccented stem following the addition of the ADJECTIVIZER suffix is shown in (135). Notice that this derivation is essentially the same as that in (131) except for the fact that the floating accent in this case is acquired from the suffix rather than from the stem.

```
(135) Input:             Suffixation:          Link Accent:

                                      - *                  *
                                                           |
        σ   σ              σ   σ               σ   σ
       /|  /|\            /|  /|\             /|  /|\
      b i h i s          b i h i s           b i h i s

      Build Foot:        Insert & Link *:      Output:

            *
            |
        σ  (σ)
       /|  /|\
      b i h i s          Blocked by OCP        bihís
```

Ramos gives no examples of accented stems with this suffix, nor does he mention its effect on the stress pattern of accented stems. I assume, therefore, that the addition of the ADJECTIVIZER suffix to an accented stem has no effect on the stem's stress pattern. This is consistent with the above analysis, as may be seen from the hypothetical derivation given in (137). Notice that, since this stem already has a floating accent of its own, the addition of the ADJECTIVIZER suffix creates an OCP violation as soon as plane conflation takes place. Consequently, one of the two accents has to delete. It is argued below (for a different situation) that the direction of deletion has to be from

left to right, as shown in (136), but the direction is irrelevant in this case.

(136) <u>Delete *</u>: * —> Ø / * ___

This rule is simply a repair strategy for OCP violations introduced through morphological concatenation. The crucial elements of the rule are (i) both the trigger and the target are stress autosegments (either linked or floating), (ii) the function is deletion and (iii) the direction of application (if the trigger happens to be linked; otherwise the direction is irrelevant) is from left to right.

Following deletion, the representation (and ensuing derivation) is indistinguishable from that of an unaffixed accented word, as shown below.[34] (Again, this output is hypothetical, for Ramos gives no examples of accented stems with the ADJECTIVIZER suffix).

```
(137) Input:                 Suffixation:             Delete *:

          *                      *       -*                *

        σ   σ                  σ   σ                     σ   σ
       /|  /|\                /|  /|\                   /|  /|\
      d u g o ?              d u g o ?                 d u g o ?
```

[34]Some languages such as Yoruba (section 2.2.3) allow two identical floating autosegments to link in a single plane by leaving an empty p-bearing unit in between them. Apparently, the grammar of Tagalog does not permit such 'skipping' during Linking, so the latter must be a non-iterative rule. See Archangeli and Pulleyblank (in press) for a discussion of this type of parametric variation between grammars.

```
Link Floating *:       Build Foot:       Insert & Link *:     Output:

      *                     *
      |                     |
  σ   σ                 σ  (σ)
 /|  /|\               /|  /|\
d u g o ?             d u g o ?          Blocked by OCP       dugó?
```

The second suffix that affects stress in Tagalog is illustrated in (138); these data are from Ramos 1971, Schachter and Otanes 1972 and Myers 1989. Notice that a stem with penultimate stress acquires final stress following the addition of this suffix, while a stem with final stress acquires penultimate stress following suffixation.

(138)	húgas	*to wash*	hugas-án	*place for washing*
	lúto?	*to cook*	lutu -án	*vessel for cooking*
	aklát	*book*	aklát-an	*library*
	tindá	*to sell*	tindá-han	*store*

How are these facts to be explained? I propose that the NOMINAL suffix *[-an]* (which is not to be confused with the transitivizer suffix *[-an]* in *pasúk-an* (128)) has its own lexical accent as shown in (139), and that NOMINAL *[-an]* does not enter the derivation until *after* the linking of a floating accent to the rightmost syllable of the word.[35]

```
(139) NOMINAL [-an]:          Transitivizer [-an]:

         *
         |
         an                       an
```

[35] I arbitrarily assume that the accent of NOMINAL *[-an]* is underlyingly linked to the vowel of the clitic. It does not appear to be possible to determine from the data whether the accent is linked or floating; this is explained below.

Since I have assumed that the linking of a stem's lexical accent is postlexical, the above proposal entails the claim that NOMINAL *[-an]* enters the derivation postlexically. Indeed, it is argued below that the linking of lexical accent must precede the suffixation of NOMINAL *[-an]*, and this is possible only if linking is strictly postlexical (unless one resorts to suspiciously stipulatory measures). Thus, I am claiming that NOMINAL *[-an]* is actually an enclitic rather than a suffix.

A sample derivation for an accented word with NOMINAL *[-an]* is given in (140). Citicization (step c) creates an OCP violation which is repaired via the application of Delete * (step d; see rule 136). Since the leftmost accent is the one that remains, it must be the case that this rule applies from left to right. Next, in keeping with the Mayo analysis, I assume that a degenerate foot is built (step e); this step is not crucial for Tagalog. Finally, the regular rule which inserts a stress autosegment into a foot is blocked from applying in this case because the foot already contains a stress.

```
(140) (a) Input:          (b) Link Floating *:  (c) Add NOMINAL Clitic:

             *                    *                     *     *
                                  |                     |     |
          σ    σ          σ       σ             σ       σ     σ
          |\  /|\         |\     /|\            |\     /|\   /|
          a k l a t       a k l a t             a k l a t - a n
```

```
(d) Delete *:              (e) Build Foot:            (f) Insert & Link *:

          *                          *
          |                          |
    σ     σ   σ              σ      (σ)   σ
    |\   /|  /|\             |\    /|   /|\
    a k l a t a n            a k l a t a n             Blocked by OCP
```

(g) Output:

aklátan

In the above derivation it does not matter whether the clitic's accent is prelinked or floating. I have assumed the former, but if the clitic's accent were in fact floating, it would still be eliminated by the application of Delete *. It is crucial, however, to assume that the stem's floating accent links to the final syllable *before* the cliticization of *[-an]*. In order to see this, consider the following. Suppose, for the sake of argument, that the linking of a floating accent were to occur after *[-an]* cliticization instead of before. This assumption entails the following analysis, illustrated in (141). First, cliticization (or perhaps suffixation) occurs. This creates an OCP violation, which in turn triggers the application of Delete *. Finally, the remaining accent links and a degenerate foot is built, producing the incorrect form **aklatán* instead of the observed *aklátan*.

```
(141) Input:                   Add NOMINAL Clitic:          Delete *:

         *                          *     *                      *
                                          |
      σ     σ                   σ     σ     σ              σ     σ   σ
      |\   /|\                  |\   /|\    |\             |\   /|  /|\
      a k l a t                 a k l a t - a n            a k l a t a n
```

```
Link Floating *:       Build Foot:              Output:

        *                      *
         \                     |
σ      σ   σ           σ     σ   (σ)
|\    /|  /|\          |\   /|  /|\
a k l a t a n          a k l a t a n            *aklatán
```

Thus, it is necessary to order the linking of a floating accent prior to *[-an]* cliticization because the opposite order predicts the wrong output. Likewise, it is crucial that the regular rule which inserts and links * in a foot has not yet applied at the point where *[-an]* is cliticized to an unaccented word. Otherwise, the word would incorrectly end up with two stresses as shown below.

```
(142) Input:                Build Foot:            Insert & Link *:

                                                    *
                                                    |
       σ   σ                 (σ   σ)               (σ   σ)
      /|  /|\                /|  /|\               /|  /|\
     h u g a s               h u g a s             h u g a s

      Add NOMINAL Clitic:    Delete *:             Output:

        *        *
        |        |
       (σ   σ)   σ
       /|  /|\   |\
      h u g a s - a n         N/A                  * húgasán
```

Notice that the the OCP is not violated in the above output, nor does the autosegmental theory of stress provide any means of eliminating the extra stress in (142) except by stipulation. I conclude, therefore, that the regular rule which inserts * into a foot and links it from left to right is ordered after the cliticization of *[-an]* to the stem, as shown in (143). This is consistent with the claim that both Foot-build-

ing and * Insertion are strictly postlexical; it is inconsistent with the claim that * Insertion is cyclic.

(143) <u>Input</u>: <u>Add NOMINAL Clitic</u>: <u>Build Foot</u>:

```
                                        *                          *
                                        |                          |
   σ   σ                  σ   σ         σ             σ   σ   (σ)
  /|  /|\                /|  /|\        |\           /|  /|\   |\
  h u g a s              h u g a s  -  a n          h u g a s a n
```

<u>Insert & Link *</u>: N/A

<u>Delete *</u>: N/A

<u>Output</u>: *hugasán*

In summary, it has to be the case that the derivation of a word containing NOMINAL *[-an]* proceeds in the following order:

(144) <u>Derivation of words containing NOMINAL *[-an]*</u>:

(a) Link a floating * to the stem from right to left.
(b) Cliticization of *[-an]*, which is lexically accented.
(c) Build a single syllabic foot from right to left.

Notice that the regular stress rule, 'Insert * in tne foot and link it from left to right', never applies to words which have been derived with NOMINAL *[-an]* because their foot already contains a stress at the time when this rule would normally apply.

One advantage of the foregoing analysis over non-autosegmental analyses of Tagalog stress is that the proposed representations of the various suffixes (and clitics) instantiate the typology of suffixes that is predicted by the autosegmental theory of stress. Given that stress is an autosegment, it should be possible for a suffix to consist of only a stress autosegment; this is exemplified by the ADJECTIVIZER suffix.

It should also be possible, of course, for a suffix (or clitic) to contain only segmental material and no stress autosegment, as is the case in many of Tagalog's suffixes that are discussed in the above-named references. The third and final logical possibility is that a suffix could contain a stress autosegment as well as segmental material; this is instantiated in the NOMINAL *[-an]* clitic. This typology is summarized below, where * represents the presence of a stress autosegment and X represents the presence of segmental material.

(145) THE TYPOLOGY OF SUFFIXES AS PREDICTED
<u>BY THE AUTOSEGMENTAL THEORY OF STRESS</u>:

$$\begin{bmatrix} * \\ \\ \end{bmatrix} \qquad \begin{bmatrix} * \\ | \\ X \end{bmatrix} \qquad \begin{bmatrix} \\ \\ X \end{bmatrix}$$

ADJECTIVIZER   NOMINAL *-an*   Conventional Suffixes

Thus, the autosegmental theory of stress not only accounts for all of the facts of Tagalog stress but also predicts a typology of suffixes that is entirely instantiated in Tagalog.

In light of the autosegmental nature of Tagalog stress and the relatively minor role of foot-building in the above proposal, a strictly non-metrical analysis of Tagalog stress suggests itself. The basic idea stems from the observation that the behavior of Tagalog's NOMINAL *[-an]* clitic is strikingly similar to the behavior of Margi's polarizing prefix that was discussed in section 2.2.2. Recall that the surface tone of Margi's present tense prefix is always the opposite of the underlying tone of the stem, so if the stem has H then the prefix gets L, but if

the stem has L then the prefix gets H. A similar approach may be applied to the Tagalog data in order to account for the behavior of NOMINAL *[-an]*. As in the metrical analysis presented above, I assume that this morpheme has a prelinked lexical accent (again, the prelinked status is not crucial) and that a floating stress autosegment in the stem will link from right to left within the stem *before* cliticization occurs. I further assume a postlexical rule which renders the final syllable of a word extrametrical. Following this rule, a stress autosegment is inserted and links to the rightmost metrical stress-bearing unit. These steps are illustrated in (146) for an unaffixed, unaccented word.

```
(146) Input:                  Link Floating *:      Add NOMINAL Clitic:

       σ   σ
      /|  /|\
     h u g a s                     N/A                   N/A

     Extrametricality:        Insert and Link *:    Output:

                                  *
                                  |
       σ  <σ>                     σ  <σ>
      /|  /|\                    /|  /|\
     h u g a s                  h u g a s           húgas
```

The same derivation is given in (147), except this time *[-an]* is added.

```
(147) Input:                  Link Floating *:      Add NOMINAL Clitic:

                                                              *
                                                              |
       σ   σ                                          σ   σ   σ
      /|  /|\                                        /|  /|  /|\
     h u g a s                     N/A               h u g a s -a n
```

```
Extrametricality:        Insert and Link *:     Output:

           *
           |
  σ   σ  <σ>
 /|  /|  /|\
h u g a s a n            Blocked by OCP         hugasán
```

It might be argued that the OCP does not apply in the above derivation because the final * is linked to an invisible anchor. If this is the case, then it will be necessary to stipulate that extrametricality is blocked from applying to a syllable which has a stress autosegment linked to it.

The same set of steps yields the following output in an unaffixed accented stem.

```
(148) Input:             Link Floating *:      Add NOMINAL Clitic:

        *                       *
                                |
      σ   σ               σ   σ
     /|  /|\             /|  /|\
    a k l a t            a k l a t                   N/A

    Extrametricality:    Insert and Link *:    Output:

          *
          |
      σ  <σ>
     /|  /|\
    a k l a t            Blocked by OCP        aklát
```

Finally, the analysis is applied to the same accented stem *aklát*, but this time the clitic *[-an]* is added.

```
(149) Input:            Link Floating *:     Add NOMINAL Clitic:

          *                    *                  *     *
                               |                  |     |
        σ   σ                σ   σ              σ   σ     σ
       /|  /|\              /|  /|\            /|  /|    /|\
      a k l a t            a k l a t          a k l a t -a n

      Delete *:            Extrametricality:    Insert and Link *:

             *                    *
             |                    |
        σ    σ    σ          σ    σ   <σ>
       /|   /|   /|\        /|   /|   /|\
      a k l a t a n         a k l a t a n        Blocked by OCP

      Output:

      aklátan
```

Notice that the above analysis does not require the construction of metrical constituents, yet it accounts for all the data and also predicts the same typology of suffixes that is predicted by the metrical analysis. The approach taken in the foregoing non-metrical analysis is parallel to that taken in Pulleyblank's tonal polarity analysis of Margi. It is true that there are substantive differences between Tagalog stress and Margi tone: Tagalog stress is realized as both length and high pitch, whereas Margi has underlying high and low tones but no tone-related length contrast. Despite these differences in phonetic substance, however, there appears to be no functional difference between Tagalog stress and Margi tone other than the fact that they link in different directions. In fact, the polarity effects in these two languages are strikingly similar.

Thus, the phenomenon of polarity is instantiated in the stress system of Tagalog. Since Pulleyblank 1986 has demonstrated that polarity is best viewed as an autosegmental process, the facts of Tagalog stress lend further support to the claim that stress is an autosegment.

In summary, I have proposed two slightly different analyses of Tagalog stress. Both of these analyses depend crucially upon the assumption that stress behaves autosegmentally. The essential difference between them is that one analysis utilizes metrical feet while the other does not. Under the non-metrical analysis, the autosegmental property of polarity is instantiated for stress in essentially the same manner as it is instantiated in Margi's tonal system. Furthermore, both analyses predict the attested typology of suffixes in terms of how an autosegmental accent might be expected to combine with segmental material.

5.4. Conclusion: Constraining the Interaction of Stress and Foot-Building.

This chapter has utilized data from Mayo and Tagalog to support the Autosegmental Stress Hypothesis, which asserts that stress is an autosegment. This hypothesis makes it possible to account for foot-related stress systems in terms of two independent processes, the construction of headless feet and the assignment of a stress autosegment to those feet. The inherent headlessness of feet in Mayo was attested by the observation that, even though foot-building has to precede and follow reduplication, the assignment of stress to feet must necessarily be delayed until the postlexical stage of the derivation. Indeed, the presence of heads during the lexical phonology, which would be required

under the theories of H&V and Hayes, would greatly complicate the analysis.

Regarding the autosegmental nature of stress, two kinds of evidence were presented. First, lexical accent in both Mayo and Tagalog floats in the same manner as autosegmental tone is known to float in a number of languages. Second, all instances of stress in Mayo's unaccented words are accounted for via a single rule which inserts and links a stress autosegment from right to left in the foot, if there is one, else in the word. The latter situation provides another argument for the separation of stress and foot structure insofar as many Mayo words never undergo Mayo's rule of foot-building even though they surface with stress. This supports the claim that stress may exist apart from foot structure at any point in the derivation, even in surface representation.

As a direct consequence of the separation of stress and feet, it was noted that the Tagalog stress data may be explained either with or without the use of feet. In either case, the source of contrastive stress in Tagalog is essentially the same as in Mayo, with one simple difference: whereas the Mayo stress contrast is due to the left to right linking of a floating lexical accent in certain words, the Tagalog stress contrast is attributed to the right to left linking of the same kind of accent in certain words. The advantage of the autosegmental theory of stress over other metrical theories is that the former provides a natural explanation for the apparent mobility of lexical accent in Mayo and Tagalog, whereas this mobility cannot be explained in any

principled manner if lexical accent is viewed merely as a static segmental feature.

Returning to the question of feet in Tagalog, it was demonstrated that a reasonable non-metrical analysis of stress is possible. In particular, all of the observed stress alternations may be accounted for by treating stress in exactly the same manner as tone is treated in languages such as Margi, i.e., as an autosegment which links directionally to the edges of words. It was argued, furthermore, that Tagalog's NOMINAL *-an* clitic exhibits essentially the same type of polarity effect as that of Margi's polarizing prefix (section 2.2.2), and the corresponding analyses are strikingly similar.

In summary, this chapter has provided evidence for the existence of headless metrical feet as well as foot-free stresses in Mayo, and it has likewise demonstrated that stress in Tagalog behaves like autosegmental tone. The next chapter summarizes the autosegmental theory of stress and discusses some residual issues regarding the claim that stress is autosegmental.

CHAPTER 6

TOWARD A UNIFIED THEORY OF PROSODY

The preceding chapters laid out the theoretical motivation as well as a broad base of empirical support for the autosegmental theory of stress. The aims of this final chapter are threefold. First, section 6.1 suggests how the proposed theory might be extended to account for two types of phenomena which were mentioned only briefly in chapter 2. These are (i) multiple degrees of stress, and (ii) 'long range' stress shift under clash, as in the English Rhythm Rule. Next, section 6.2 discusses a potential objection to the autosegmental theory of stress. This concerns the observation that stress autosegments never seem to undergo the autosegmental process of spreading. It is suggested, as a preliminary explanation, that stress cannot undergo spreading because to do so would conflict with its central function in setting off one element in a representation as more prominent than all the others. The final aim of this chapter, which is covered in section 6.3, is to present a brief synopsis of the autosegmental theory of stress.

I begin with a discussion of how the theory proposed in chapter 2 might be extended so as to account for the existence of multiple degrees of stress within a single domain.

6.1. Accounting for Multiple Degrees of Stress.

Although the focus of this study has been the development of a theory of stress placement, chapter 2 briefly mentioned two types of phenomena which imply the existence of some kind of hierarchical rela-

tionship between individual stresses. One of these is the occurrence of multiple degrees of stress in a large number of languages. The other phenomenon might be referred to as 'long range' stress shift; section 2.2.1 discussed the English Rhythm Rule as an example of this. In this section I suggest how the autosegmental theory of stress might be extended in order to account for these two sets of phenomena.

Looking first at the occurrence of multiple degrees of stress, how might the autosegmental theory of stress be extended or augmented in order to account for this phenomenon? Before attempting to answer this question, consider how the theories of Hayes, Hammond and H&V have handled multiple degrees of stress. Since each of these theories views the foot as a grouping of abstract terminal elements, one of which has to be a head, it is quite natural for the heads of feet to themselves be grouped into super-feet, also known as *cola* (Stowell 1979, Hammond 1987a) or *word trees* (Hayes 1981). One of the members of each colon or word tree is then designated as the head using the same kinds of devices that are available for designating one of a foot's terminal elements as the head of that foot. This process, which may be repeated for as many levels as necessary in order to derive all of the observed degrees of stress, was illustrated in section 1.2.2.

The same basic approach may be applied to stressed feet that have been derived under my proposal. The only difference is that feet are headless in my theory, so it is not possible to group heads into cola. Instead, the stresses themselves must be grouped into cola. A stress autosegment is then inserted and linked (on a higher line) in each

colon. The docking point in this case is a foot-level stress autosegment, and the direction of linking may or may not be the same as the direction of linking of the foot-level stress. This is illustrated schematically below.

```
(1)                 *
                    |
            (*      *)
             |      |
            (σ σ)(σ σ)        Example:  Mìssissíppi
```

Higher-level cola may subsequently be built in order to create as many degrees of stress as needed. Following the theories of Hammond 1987a and H&V, I assume that the the phonetic distinctions between the various degrees of stress are generated during phonetic implementation.

Next, consider how this approach might be used to account for the case where stress shifts (under clash) to a stress-bearing unit which is not adjacent to the stress-bearing unit that it shifted from. Section 2.2.1 cited the English Rhythm Rule (Chomsky and Halle 1968, Liberman and Prince 1977, Kiparsky 1979, Prince 1983, Hayes 1984, Halle and Vergnaud 1987b, Hammond 1988a) as an example of such a phenomenon. A sample set of the relevant facts is repeated below from section 2.2.1. The basic observation is that the leftmost of two primary stresses moves leftward (to the site of a formerly subsidiary stress) when the two primary stresses occur on adjacent syllables in certain phrase-level contexts.

(2) (a) Tènnessée (b) Ténnessèe Wílliams
(3) (a) Mìssissíppi (b) Míssissìppi Ríver
(4) (a) àpalàchicóla (b) ápalàchicòla ármie

Three observations should be noted about (2) through (4). First, unlike the movement under clash that occurs in Italian (section 2.2.1), the movement in this case is 'long distance' in the sense that it skips one or more intervening stress-bearing units. Second, the movement is not to a formerly stressless position but rather to a position which already bore non-primary stress. Third, the position from which primary stress moves does not become stressless. Rather, it acquires a non-primary stress. Thus, the Rhythm Rule has the effect of 'swapping' the positions of a primary and a non-primary stress in order to resolve a clash between two primary stresses within a phrase.

The model in (1) may be used to derive the English Rhythm Rule as follows. First, the output of all lexical stress assignment rules is derived by building cola on top of foot-level (i.e., line 1) stresses, as shown in (5).

(5) <u>Output of Lexical Rules</u>:

```
            *                *
            |                |
  (*        *)              (*)
   |        |                |
  (σ   σ)  (σ   σ)          (σ   σ)
  /|  /|   /|  /|           /|  /|
[M iss iss ipp i] ... [R i v er]        [Mississíppi] ... [Ríver]
```

Next, Bracket Erasure (i.e., entering the post-lexical phase) results in an OCP violation in that two tokens of line 2 * are linked to adjacent tokens of line 1 *. This is resolved by delinking the leftmost line 2 * and relinking it from left to right to the first potential anchor, which

is the leftmost token of line 1 *. The resulting representation is illustrated below.

(6) Output of Clash Resolution:

```
 *                  *
 |                  |
(*        *)       (*)
 |        |         |
(σ   σ) (σ   σ)    (σ   σ)
/|  /|  /|  /|     /|  /|
M iss iss ipp i    R i v er        Míssissìppi Ríver
```

Thus, the English Rhythm Rule may be derived by building super-feet (or cola) which consist only of autosegmental stresses and then directionally linking a second stress autosegment (on line 2) in each super-foot. The OCP forces the leftmost of two adjacent line 2 stresses to delink; it then relinks to the leftmost line 1 stress. It is possible that other approaches would also be compatible with the theory of stress that has been proposed in this study; I leave this as an area for future research.

In conclusion, the existence of multiple degrees of stress within a single domain does not pose a problem for the autosegmental theory of stress, nor does the English Rhythm Rule pose a problem. In both cases I follow the theories of Hammond 1987a and H&V in constructing super-feet from lower level stresses.

Next, I discuss the autosegmental process of spreading and its relationship to the autosegmental theory of stress.

6.2. Can Stress Spread?

Chapter 2 pointed out that a common property of autosegments is their ability to link to more than one p-bearing unit at the same time; this is generally known as *one-to-many mapping*. As was stated in chapter 2, the autosegmental theory of stress predicts that one-to-many mapping should be able to apply within stress systems, and yet this seems to be unattested. That is, stress does not appear to spread. Rather, stress normally surfaces on only one terminal element of a foot or word. If stress is in fact an autosegment, then why don't we observe instances of stress spreading to a neighboring terminal element?

The failure of stress to spread within a foot cannot be attributed to any property of feet for two reasons. First, chapter 2 argued that feet are not utilized in unbounded stress systems, and yet unbounded stress has never been observed to spread. Even if it were the case that some inherent property of feet were preventing foot-bound stress from spreading, this could not account for the failure of stress to spread in unbounded stress systems.

The second reason why the failure of stress to spread within a foot cannot be attributed to any property of feet is that foot-bound spreading processes are in fact attested. If the foot itself were somehow responsible for the failure of stress to spread, it should prevent other autosegments from spreading as well, yet this is not the case. At least two instances of foot-bound tonal spreading processes have been

reported. One of these concerns the Capanahua data which were described and analyzed in section 4.2; the other is discussed below.

Yip 1984 claims that foot-bound tonal spreading occurred in Chinese verse of the 6th century A.D. Yip points out that feet had been used in Chinese verse for many centuries prior to this time, but that it was right around the 6th century when tones began to appear in Chinese. It is known that tones arose from distinctions in syllable closure, and yet these distinctions were not utilized for versification until they switched from being distinctions in syllable type to being tonal distinctions. (See Yip 1984 for references which argue for these claims).

The role of these tones in Chinese versification was as follows. Rather than having one prominent syllable per foot, as is usually observed in stress systems, both syllables of a given foot had to have the same tone, thus restricting the poet's selection of lexical items for a given context. Furthermore, in those cases where the tone of a syllable was not underlyingly specified, it acquired the tone of its immediate neighbor within the same foot. Thus, this is a clear case of one-to-many mapping of a tonal autosegment within a foot. (The reader is referred to Yip 1984 for the data which support this claim).

Interestingly enough, the Chinese foot came into disuse shortly after the introduction of tones into the grammar. Yip 1984 suggests, as an explanation for this development, that the role of the foot as a rhythmic organizer was obscured by the introduction of multiple lexical tones; I do not pursue this hypothesis here.

Thus, 6th century Chinese apparently exhibited one-to-many mapping of tonal autosegments within feet, but foot structure apparently disappeared from Chinese grammar shortly after one-to-many mapping was innovated. In addition, section 4.2 discussed a present-day example of foot-bound tonal spreading in Capanahua. Two points should be noted regarding these spreading processes. First, they constitute further evidence for the Foot-as-Domain principle (section 2.3.3.1). Second, they demonstrate that the foot cannot be responsible for the failure of stress to spread, for if that were the case, then it would not be possible for tone to spread within a foot, and yet such spreading is attested.

I have not been able to find any other instances of tone spreading within a foot, but van der Hulst and Smith 1982 discuss two purported examples of foot-bound spreading of the feature [NASAL]. One of these occurs in Applecross Gaelic, in which the leftward spread of [+NASAL] never extends beyond the onset of the stressed syllable. The other example comes from Brazilian Guaraní, in which the foot is argued to be the domain into which nasal autosegments are inserted, linked and spread. However, since each of these languages allows [NASAL] to spread beyond two syllables, and since section 2.1.1 argued that feet are at most binary, it is not clear that the spreading processes in these languages are blocked by foot boundaries. Rather, it is the presence of stress itself which appears to block the spreading of [NASAL], despite the fact that the latter is not considered to be a distinctive feature

of stress in either of these languages. Thus, these data do not seem to constitute genuine examples of foot-bound spreading.

In summary, one-to-many mapping of foot-bound tonal autosegments is in fact attested in at least two languages, and yet it appears that there are no instances of the spreading of a foot-bound stress autosegment, nor does stress appear to spread in any other domain. Why should this be so? I suggest, as a preliminary answer, that one-to-many mapping is incompatible with the primary function of stress, which is to single out one element in a representation as more prominent than all the others. In other words, since spreading rules are attested for other autosegments both within the foot as well as within the word, it should be possible for a grammar to have a rule which spreads a stress autosegment. The complete absence of spreading processes which target the stress autosegment may well be due to stress's primary function of singling out one terminal element and making it more prominent than all the others.

In conclusion, the absence of spreading processes which target stress autosegments cannot be attributed to any property of feet. Rather, this has to be viewed as an idiosyncratic property of the stress autosegment just as downstep is considered to be an idiosyncratic property of tone. I assume, as a preliminary hypothesis, that spreading is simply incompatible with stress's primary function of singling out one terminal element and making it more prominent than all others. However, since the pursuit of this hypothesis could easily constitute a lengthy study in its own right, I leave it as a topic for future investigation.

6.3. A Summary of the Autosegmental Theory of Stress.

The central claim of this study has been that stress is an autosegment, but many of the arguments for this claim have made use of the independent claim that stress must be separated from foot structure. Accordingly, chapter 2 began with a review of the arguments for the latter. This was broken down into two steps. First, it was argued that metrical heads are redundant and therefore should not be included in a theory of stress. Instead, the concrete feature (or set of features) known as *stress* may be used to account for all phenomena which heretofore have been attributed to metrical heads. Second, it was argued that stress and metrical feet are in fact separate entities. In order to demonstrate this claim, two sub-points were established: (i) metrical feet can exist without any corresponding stress, and (ii) stress can exist without any corresponding metrical feet. Evidence for the first sub-point came from the theory of prosodic morphology (McCarthy and Prince 1990, Crowhurst 1991b) as well as from the facts of Yidin^y stress (Dixon 1977, Crowhurst 1991a, Crowhurst and Hewitt, to appear). Evidence for the second sub-point came from arguments for the autosegmental nature of stress. These arguments were based on a comparison of the set of all autosegmental properties with the set of all the properties of stress. After eliminating those differences which pertain only to phonetic substance and not to formal behavior, it was concluded that the formal behavior of stress is essentially identical to the formal behavior of autosegments, i.e., stress is an autosegment.

It was also pointed out that the separation of stress and metrical feet is not new to the theory presented here. For example, although H&V assume that metrical feet have heads, the possibility of headless metrical feet is built into their formalism by virtue of the fact that their rules of constituent construction make no direct reference to heads. Rather, the assignment of heads to feet is handled by a separate rule or set of rules ordered after the rules which generate metrical constituents. Since the assignment of heads is explicitly ordered as a separate rule following the construction of feet, there exists a point at which feet are headless. Assuming, furthermore, that individual grammars are free to select some rules and omit others, H&V thus predict that a language might have a rule generating metrical constituents but no rule assigning heads to those constituents. Halle and Idsardi 1992 are even more explicit in separating heads and feet. However, all heads are derived from metrical structure in their theory, whereas in my theory heads are completely replaced by stress, which is formally independent of metrical structure.

The autosegmental nature of stress was then formalized as the Autosegmental Stress Hypothesis. Based on Hayes' 1991 inventory of feet, a simple inventory of primitive headless feet was proposed, and the following inventory of headed feet was generated by applying the Autosegmental Stress Hypothesis to the proposed headless feet.

(7) <u>The Surface Typology of Binary Headed Feet</u>:

(a) <u>Syllabic, Left-headed</u>:

$$\begin{array}{ll} * & \\ (\sigma & \sigma) \end{array}$$

(Warao)

(b) <u>Syllabic, Right-headed</u>:

$$\begin{matrix} & * \\ (\sigma & \sigma) \end{matrix}$$

(Mayo)

(c) <u>Moraic, Left-headed</u>:

$$\begin{matrix} * & \\ (\mu & \mu) \end{matrix}$$

(Cairene Arabic)

(d) <u>Moraic, Right-headed</u>:

$$\begin{matrix} & * \\ (\mu & \mu) \end{matrix}$$

(Turkish)

(e) <u>Iambic</u>: <u>Preferred</u>: <u>Else</u>:

$$\begin{matrix} & * \\ (\mu & \sigma_{\mu\mu}) \end{matrix} \qquad \begin{matrix} & * \\ (\mu & \mu) \end{matrix}$$

(Hixkaryana)

In addition to the Autosegmental Stress Hypothesis, this proposal has invoked four basic principles. These are the Foot-as-Domain Principle, the Weight-to-Stress Principle, the Degenerate Foot Principle and the Uniform Linking Constraint. The latter is a universal constraint on word-level representations which follows from H&V's Recoverability Condition and is required by other theories of stress including those of H&V, Hammond 1990b and Hayes 1987, 1991. The remaining three principles define the three ways in which individual stresses may be linked within feet. By assuming that stress is a distinct autosegment unique from tone and other autosegments, it is possible for these special principles to apply uniquely to stress just as other principles apply only to certain other autosegments.

The Weight-to-Stress Principle additionally makes it possible to account for unbounded stress systems without the use of feet. In conjunction with the autosegmental theory of stress, this principle predicts exactly six types of 'unbounded' stress systems. Section 3.2 argued that these six systems are in fact the only ones that are attested.

The chart in (8) summarizes the typology of stress that is predicted by combining autosegmental theory with the Foot-as-Domain Principle and the Weight-to-Stress Principle.

(8) Word and Foot as Domains of Stress Assignment:

	Foot-Building: Yes	Foot-Building: No
Stress Domain: Word	Old English	Huasteco
Stress Domain: Foot	Warao, C. Arabic	(Not possible)

Chapter 4 demonstrated that Yidin^y is somewhat unusual in that the Weight-to-Stress Principle plays a role in stress assignment even though the foot-building process is insensitive to syllable weight. It was argued that the proposed autosegmental analysis is superior to other analyses that have been proposed because the former utilizes only independently required principles and devices, whereas other analyses of Yidin^y have been forced to include *ad hoc* devices as a result of the incorrect assumption that feet have inherent heads.

Chapter 5 argued that stress is capable of floating in Mayo and Tagalog. The facts of Mayo require not only that stress be treated as an autosegment but also that stress be capable of being inserted and linked in the word domain as well as in the foot. It was argued that the theories of H&V and Hayes are incapable of accounting for the facts of Mayo stress without resorting to *ad hoc* devices.

This chapter began by considering how the proposed theory might be extended to account for multiple degrees of stress as well as 'long

range' stress shift under clash, as in the English Rhythm Rule. I then addressed the question, which was raised in section 2.2.3, of why there appear to be no spreading processes which target the stress autosegment. It was noted that this fact cannot be attributed to any property of feet, for at least two instances of foot-bound spreading of tone have been noted. It was suggested, as a preliminary explanation for the failure of stress to undergo spreading, that one-to-many mapping is incompatible with the primary function of stress, which is to single out one element in a representation as more prominent than all the others.

Further issues remain to be resolved. One of these concerns the question of whether stress is a unique autosegment or whether it is simply parasitic on other autosegments. Although I have assumed throughout this study that stress is an autosegment, I have not attempted to define it in terms of specific phonetic features. If there is no unique stress autosegment, i.e., if stress systems are free to utilize any autosegment to represent stress, then it must be explained why only a small subset of the universal inventory of autosegments is utilized by stress systems. If, on the other hand, there is a unique stress autosegment which is different from all other autosegments, then it remains to determine what it is that makes this autosegment phonetically distinct from other autosegments such as tone, [NASAL], [BACK] and [ATR]. I leave this as a question for future research.

Another issue concerns the representation of multiple degrees of stress. Although a tentative proposal was suggested in section 6.1, it entails the admission of a new foot type, one which is constructed from

stress autosegments rather than from syllables or moras. Again, I have left this as an untested hypothesis for future investigation.

In conclusion, the theory proposed here derives all of the observed properties of stress from independently-needed principles and devices. In particular, it has been shown that stress behaves as an autosegment which, in many cases, utilizes the foot as the domain in which linking and other autosegmental processes occur. By viewing stress as an autosegment, many of the rules, devices and parameters which heretofore have been used only to describe stress (such as conflation, stress clash resolution and boundedness, to name but a few) may be eliminated. Thus, the autosegmental theory of stress constitutes a significant simplification of phonological theory in general.

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